BIOACTIVE POTENTIALS OF SELECTED MALVACEOUS PLANTS

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นันทพร ดิลกานนท์ : การประเมินฤทธิ์ทางชีวภาพของพืชสมุนไพรบางชนิดในวงศ์ฝ้าย (BIOACTIVE POTENTIAL OF SELECTED MALVACEOUS PLANTS)
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การประเมินฤทธิ์ทางชีวภาพของพืชสมุนไพรบางชนิดในวงศ์ฝ้าย มีวัตถุประสงค์เพื่อจะทดสอบหาฤทธิ์ทางชีวภาพของพืชบางชนิดในวงศ์นี้ พืชแห้งจากส่วนของ ราก ลำต้น และ ใบของต้นหญ้าขัดมอญ ต้นครอบฟันสี และ หญ้าเทวดา ถูกสกัดด้วยวิธีการสกัดแบบต่อเนื่อง (soxhlet apparatus) ในไดคลอร์โรมีเทน และเมทานอล ตามลำดับ การทดสอบฤทธิ์ต้านจุลชีวินพบว่าหญ้าขัดมอญ มีฤทธิ์ในการต้านจุลชีวินทั้งหมดที่ศึกษา แต่ฤทธิ์ที่พบแตกต่างกันไปตามชนิดของเชื้อ ส่วนที่ใช้ของพืชและตัวทำละลายที่นำมาสกัด เมื่อทำการทดสอบฤทธิ์การต้านเชื้อมาลาเรียสายพันธุ์*P. falciparum* K1 (ต้านต่อยาคลอโรควิน) และ 3D7 (ไวต่อยาคลอโรควิน) พบว่าส่วนของใบหญ้าขัดมอญที่สกัดด้วยเมทานอลมีฤทธิ์ดีในการต้านเชื้อมาลาเรีย ซึ่งมีค่าความเข้มข้นที่ยับยั้งเชื้อได้ร้อยละ50(IC_{50})ที่4.60 และ 4.00 ไมโครกรัมต่อมิลลิลิตรตามลำดับอัลคาลอยด์ที่สกัดจากต้นหญ้าขัดมอญทั้งต้นให้ฤทธิ์ยับยั้งเชื้อมาลาเรียที่IC_{50}6.26 และ 9.36 ไมโครกรัมต่อมิลลิลิตรตามลำดับ ในการทดสอบฤทธิ์การยับยั้งเอนไซน์แอลฟากลูโคซิเดส และเอนไซม์แอลฟาอะไมเลสของพืชทั้งสามต้น พบว่าสารสกัดจากรากของครอบฟันสีที่สกัดด้วยไดคลอร์โรมีเทนให้ฤทธิ์การยับยั้งที่ดีในการยับยั้งเอนไซม์แอลฟากลูโคซิเดสจากยีสต์เมื่อเทียบกับสารมาตรฐานดีออกซีนอจิริไมซินโดยมีค่า IC_{50}อยู่ที่ 0.36 และ 0.58 มิลลิกรัมต่อมิลลิลิตร นอกจากนี้สารสกัดจากครอบฟันสีในส่วนของรากที่สกัดด้วยเมทานอลมีฤทธิ์ดีในการยับยั้งเอนไซม์แอลฟากลูโคซิเดสจากลำไส้เล็กของหนูเมื่อเทียบกับสารมาตรฐานดีออกซีนอจิริไมซินโดยมีค่า IC_{50}0.08 และ 0.11 มิลลิกรัมต่อมิลลิลิตรตามลำดับ และยังพบว่าส่วนของรากที่สกัดด้วยไดคลอร์โรมีเทนและลำต้นที่สกัดด้วยเมทานอลจากต้นหญ้าขัดมอญให้ค่าการยับยั้งเอนไซม์แอลฟาอะไมเลสที่ดีเมื่อเทียบกับสารมาตรฐานอะคาร์โบสโดยมีค่า IC_{50}0.07และ2.7มิลลิกรัมต่อมิลลิลิตรตามลำดับ จากการทดสอบฤทธิ์ต้านออกซิเดชันด้วยวิธีการต้านอนุมูลอิสระดีพีพีเอชพบว่าสารสกัดจากรากในต้นหญ้าขัดมอญที่สกัดด้วยไดคลอร์โรมีเทนให้ฤทธิ์ที่ดี (IC_{50} = 0.20 มิลลิกรัมต่อมมิลิลิตร) ในการทดสอบฤทธิ์ต้านไนตริกออกไซด์พบว่าสารสกัดจากส่วนใบของต้นหญ้าขัดมอญที่สกัดด้วยไดคลอร์โรมีเทนให้ฤทธิ์ที่ดี (IC_{50}=0.11มิลลิกรัมต่อมิลลิลิตร) นอกจากนี้สารสกัดในส่วนของใบที่สกัดด้วยไดคลอร์โรมีเทนและรากที่สกัดด้วยเมทานอลของต้นหญ้าขัดมอญให้ค่าที่ดีในการคีเลทไอออนของโลหะ (IC_{50}=1.6 มิลลิกรัมต่อมิลลิลิตร) การทดสอบความสามารถในการรีดิวซ์พบว่าส่วนของใบที่สกัดด้วยไดคลอร์โรมีเทนจากหญ้าขัดมอญมีพลังรีดิวซ์ดีที่สุด(IC_{50}=2.45 มิลลิกรัมต่อมิลลิลิตร) ไม่พบความเป็นพิษของหญ้าขัดมอญในการทดสอบความเป็นพิษต่อไรทะเล (LC_{50}>9000 มิลลิกรัมต่อมิลลิลิตร)โดยสรุปหญ้าขัดมอญ หญ้าเทวดาและครอบฟันสีให้ฤทธิ์ที่ดีในการยับยั้งเอนไซม์ที่สำคัญต่อการย่อยคาร์โบไฮเดรตซึ่งควบคุมปริมาณน้ำตาลในเลือด และต้นหญ้าขัดมอญมีศักยภาพในการต้านจุลชีวิน ต้านมาลาเรีย และต้านอนุมูลอิสระ

สาขาวิชา วิทยาศาสตร์สาธารณสุข ลายมือชื่อนิสิต……..
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KEYWORDS : BIOACTIVE/ ANTIMALARIAL / ANTIMICROBIAL / ALPHA-GLUCOSIDASE / ALPHA-AMYLASE / TOXICITY

NANTAPORN DINLAKANONT: BIOACTIVE POTENTIALS OF SELECTED MALVACEOUS PLANTS. ADVISOR: CHANIDA PALANUVEJ, Ph.D., CO-ADVISOR: ASSOC. PROF. NIJSIRI RUANGRUNGSI, Ph.D. 196 pp.

Bioactive potentials of selected Malvaceous plants were studies*in vitro*. The purposes of this present study were to investigate the bioactive properties of selected Malvaceae plant materials. The crude drugs from stems, roots, and leaves of *Sidaacuta*Burm. f., *Abutilon indicum*(Linn.) Sweet and *Malvastrumcoromandelianum* (Linn.) Garcke were sequentially extracted by soxhlet apparatus with dichloromethane and methanol respectively. The study found that *S. acuta* exhibited antimicrobial potential against all tested microorganisms. However, the antimicrobial effect was selective depended on the microorganism species as well as parts of the plants and types of extractives solvents. The methanolic extract of leaves of *S. acuta* showed promising antimalarial activity against both K1 chloroquine resistant and 3D7 chloroquine sensitive*P. falciparum* with the IC_{50} of 4.60 and 4.00µg/ml respectively. Crude alkaloid was isolated from *S. acuta* whole plants and demonstrated antimalarial activity with IC_{50} of 6.26 and 9.36 µg/ml respectively. The yeast alpha-glucosidase, rat alpha-glucosidase and pancreatic alpha-amylase inhibition testings among *S. acuta, A. indicum* and *M. coromandelianum* extracts were determined*in vitro*. The results showed that the dichloromethane extracts of roots from *A. indicum* had strong effect on yeast alpha-glucosidase inhibition compared to 1-deoxynojirimycin with the IC_{50} of 0.36 and 0.58 mg/ml respectively. The methanolic extract of roots from *A. indicum* has a highest effect on rat alpha-glucisidase inhibition compared to 1-deoxynojirimycin with the IC_{50} of 0.08 and 0.11 mg/ml respectively. Moreover, the results showed that the dichloromethane extracts of roots and methanolic extracts of stems from *M. coromandelianum* had a strongest effect on alpha-amylase inhibition compared to acarbose with the IC_{50} of 0.07 and 2.7 mg/ml respectively. The greatest scavenger of DPPH radical was dichloromethane extracts of *S. acuta* roots (IC_{50}=0.20 mg/ml). The highest NO scavenging activity was shown from the dichloromethane extract of *S. acuta* leaves (IC_{50}=0.11 mg/ml). The dichloromethane extract of leaves and methanolic extract of roots from *S. acuta* showed great potential on metal chelation with IC_{50} of 1.6 mg/ml. However, the highest reducing capacity was exhibited by the extracts of leaves from dichloromethane fraction of *S. acuta* (IC_{50}=2.45 mg/ml). Furthermore, Brine shrimp lethality assay demonstrated that all tested concentrations of *S. acuta* caused no lethality to brine shrimp (LC_{50} value >9000 µg/ml). Selected Malvaceous plants including *S. acuta, M. coromandelianum* and *A. indicum* demonstrated potent inhibitory activities against key carbohydrate digestive enzymes which control postprandial blood glucose level. *S. acuta* was revealed for its potency on antimicrobial, antimalarial and antioxidant activities.

Field of Study :Public Health Sciences ..... Student's Signature .....

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LIST OF ABBREVIATIONS

ATCC	=	American type culture collection
BHT	=	Butylatedhydroxyltoluene
°C	=	Degree Celsius
CFU	=	Colony forming unit
cm	=	Centimeter
DMSO	=	Dimethylsulfoxide
g	=	Gram
hrs	=	Hours
MBC	=	Minimum bactericidal concentration
MFC	=	Minimum fungicidal concentration
MHA	=	Mueller Hinton agar
MHB	=	Mueller Hinton broth
MIC	=	Minimum inhibitory concentration
mm	=	Millimeter
mg	=	Milligram
ml	=	Milliliter
min	=	Minute
NA	=	No activity
NT	=	Non toxic
SD	=	Standard deviation
SDA	=	SabouraudDextose agar
SDB	=	Sabouraud Dextrose broth
sp	=	Species
µg	=	Microgram

µl	=	Microliter
nm	=	Nanometre
UV	=	Ultraviolet
α	=	Alpha

CHAPTER I

INTRODUCTION

Background and significance of the study

Biological studies of plant extracts have been carried out to verify pharmacological properties of the plants. Infectious diseases are caused by pathogenic microorganisms, such as bacteria, viruses, parasites or fungi. Diseases can spread directly or indirectly from one person to another. Infectious diseases are the second leading cause of death worldwide after heart disease, and are responsible for more deaths annually than cancer. WHO estimates that in 2010 malaria caused 149-274 million clinical episodes and 537,000 – 907,000 deaths. Malaria parasites in west Thailand are becoming resistant to artemisinins, which are the world's most effective antimalarial drugs [1]. The use of plants for prevention and treatment of diseases are the earliest type of medicine on earth. The ability of the plant extract to kill or inhibit the growth of microorganisms and parasites are interesting to the development of antimicrobial and antimalarial agents. A biological antioxidant can be defined as "any substance that, when present at low concentrations compared to those of an oxidisable substrate, significantly delays or inhibits the oxidation of the substrates" [2]. The free radical scavenging activities, metal ion reduction, chelating properties, peroxide and nitric oxide inhibitory potential are known to eliminate and prevent the generation of free radical. Antioxidation property has been contributing directly and indirectly to the prevention and cure of diabetic complications. In addition, the ability of medicinal plants to inhibit glucose metabolizing enzyme is of interest for the development of antidiabetic agent. Along with the determination of pharmacological properties of the plant extract, study on cytotoxicity of plant is indispensable to assure the safety of the extract. The practices of traditional medicine were developed along with the cultures of ancient Thailand and other places. Since the last decade, herbal medicines are becoming very popular and developmental in many countries around the world. The herbal medicines are also used as remedies and raw materials for the pharmaceutical industry.

Thailand has long history of plants application both as medicine and food. Malvaceae family is one of the plants in Thailand known as plant for medicine. It is a family of flowering plants containing over 200 genera with close to 4,225 species of herbs, shrubs and trees. Representatives occur in all except the coldest parts of the world but are most numerous on the tropics. There are many malvaceous plants in Thailand which have not yet been investigated mainly due to underutilized plant species. Nevertheless, the studies carried out on Malvaceous plants about pharmacological value have been reported [3]. *Sida acuta* Burm. f. is a small shrub, belonging to the Malvaceae family, locally known as Ya-kud-mon. It is found widely in the tropics and it is commonly found on abandoned areas especially by roadsides and wastelands. Thai people use this plant species for treatment of diabetes mellitus, malaria, diarrhea and many other infectious diseases [4]. Furthermore, *Abutilon indicum* (Linn.) Sweet and *Malvastrum coromandelianum* (Linn.) Garcke are another Malvaceous plants previously reported of the hypoglycemic potential in animal model [5-7].

The purposes of this present study are to investigate the bioactive properties of selected Malavaceae plant materials. Additionally, the alkaloids in *S. acuta* are qualitatively characterized. This study will provide scientific information to continually validate the potential of the plants known as ethnomedicine in Thailand.

Objectives of the study

1. To evaluate the α-glucosidase and α-amylase inhibitory activities among *S. acuta, A. indicum* and *M. coromandelianum* extracts.
2. To evaluate the biological activities of *S. acuta* extracts.

Benefit and application

1. This research provides *in vitro* scientific evidences in efficacy and safety of *S. acuta* plants which needed for step of clinical trials.
2. The results from this study contribute the use of *S. acuta* in Thai folk medicine.

CHAPTER II

LITERATURE REVIEWS

Figure 1 *Sida acuta* Burm.f. **[8]**

***Sida acuta* Burm.f.**

Thai name: Ya khat bai yao, Ya khat mon, Ya kho (Northern); Na-khui-mi, No-khui-me, No-khe, No-khue-mae (Karen-Mae Hong Son); Yung kwat, Yung pat (Central)

Family: Malvaceae

Description: *Sida acuta* Burm.f. is a small shrub, belonging to the Malvaceae family, it is found widely in the tropics and it is commonly found on abandoned areas especially by roadsides and wastelands [4]. An erect, branched, nearly glabrous herb or small shrub, 30-100 cm tall with a strong taproot, stems and branches flattened at the tips; leaves oblong-lanceolate to linear, 2-9cm ×0.5-4cm, base acute to rounded, apex acute, margins serrate-dentate, lower surface glabrous or with short stellate hairs, petiole 3-6 mm long, at least one stipule of each pair lanceolate-linear, 1-2 mm broad, often curved, ciliate, the other narrower; flowers solitary, or densely crowded on side-

shoots, 1.3 cm in diameter, pedicel 3-8 mm, petals emarginate, 6-8 mm long, pale yellow; mericarps 5-8, 3.5 mm long, awns 1-1.5 mm long, glabrous [9].

Chemical constituents and pharmacological investigations

Previous studies reported that the plants contain crytolepine, 11-metoxyquindoine, N-trans-feruloylyramine, ecdysterone, stigmesterol, canpesterol, beta-sitosterol, evofolin-B, 4-ketopinoresinol, quidolinone, cryptolepinone and loliolide cryptolepine and quindoline [10,11].

The phytochemical studies on *S. acuta* resulted in the isolation of several alkaloids and steroidal compounds with the potential to induce quinone reductase and to inhibit 7, 12-dimthylbenz-(a) anthacene induced preneoplastic lesions in mouse mammary organ [4,10,11]. Moreover, the alkaloid compounds isolated from *S. acuta* appeared to be of great interest in pharmacological studies such as antimicrobial, antiprotozoal, antihyperglycemic and cytotoxic effects through GC-rich DNA sequence intercalation that provides basis for design of new anticancer drug [12]. In addition, the previous study also reported that polyphenol extract of the plant had a weak antioxidant activity through *in vitro* free radicals scavenging assays, however the extract was very active on pathogenic bacteria and this activity may be influenced by the polymerization size of the phenolic compounds [13].

Traditionally uses: In general, the decoction, infusion or pressed juice of the mucilaginous leaves and bitter roots of the plants are used for cooling, emollient, diuretic and febrifuge purpose, to treat gonorrhea and rheumatism and externally as a poultice for boils, ulcer, swellings, cuts, coughs and chickenpox. The crushed leaves or roots are used for headache, toothache, fever, constipation, chronic and chronic bowel complaints [14-19].

Figure 2 *Abutilon indicum* (Linn.) Sweet [20]

***Abutilon indicum* (Linn.) Sweet**

Thai name: Top taep (Ratchaburi); Pop paep, Ma kong khaao (Northern); Phong phaang (Nakhon Ratchasima)

Family: Malvaceae

Description: *Abutilon indicum* (Linn.) Sweet occurs in tropical and warm temperature countries throughout the world. It is a shrub which can grow up to 1 m high. The leaves are stalked measuring 2.5-10 cm long with 2-7.5 cm wide, ovate or orbiculate to cordate, irregularly crenate or denate, acuminated, minutely hoary tomentose on both surfaces. The flowers are orange-yellow in color, solitary, axillary. The fruits are hispid, scarcely longer than the calyx and the awns are erect. The seeds

are three to five in number, kidney-shaped, dark brown or black in color, tubercles or with stellate hairs [21].

Chemical constituents and pharmacological investigations:

Previous studies were found that *A. indicum* consisted of gallic acid, asparagines, fructose, beta-sitosterone, vanillic acid, p-coumaric acid, p-coumaric acid, p-hydroxybenzoic acid, caffeic acid, fumaric acid, p-bata-D-glycosyloxybenzoic acid, leucine, histidine, threonine, serine, glutamic acid, aspartic acid and galacturonic acid, alantolactone, isoalantolactone, thereonine, glutamine, serine, proline, glycine, alanine, cycteine, methionion, isoleucine, valine, leucine, tyrosine, phenylalanine, histidine, lysine, arginine [22,23].

According to many scientific reports, the root of *A. indicum* has a diuretic property and can be taken for the relief of hematuria. It is also effective in the treatment of leprosy. Moreover, the seed of this plant are considered to be aphrodisiac and can be used as laxative for those having hemorrhoids and in the treatment of coughs, puerperal disease, urinary disorders, chronic dysentery and fever. Furthermore, the polyherbal formulations of the plant have also been reported as being effective in treating diabetes, hyperlipidemia and free radical scavengers [24-28].

In 2009, Peungvicha *et al.* has reported that the aqueous extract of *A. indicum* plant has antidiabetic properties, which inhibited glucose absorption and stimulated insulin secretion. The results showed that the extract at concentrations of 0.156 to 5 mg/mL caused a reduction of glucose absorption in a dose response manner and the maximum response was noted at a dose of 2.5mg/ml. In addition, the plasma glucose level could be reduced through the inhibition of glucose absorption and/or the enhancement of insulin secretion. Administration of the extract (0.5 and 1g/kg of body weight) in an oral glucose tolerance test led to a significant reduction in plasma glucose levels in 30 minutes after the administration in moderately diabetic rats, as compared with untreated rats ($P< 0.05$), this was also faster rate than the use of antidiabetic drug, glibenclamide. The phytochemical screening also demonstrated that the extract contained alkaloids, flavonoids, tannins, glycosides and saponins [5].

Traditionally uses: The juice from leaves has been used to formulate into an ointment for quick ulcer healing. The extracts are also used as treating bronchitis, diarrhea, gonorrhea and inflammation of the bladder and in reducing of fever. In addition it is used in cleaning wounds and ulcer, treating vaginal infection, diabetes, hemorrhoids and enema [24,25].

Fugure 3 *Malvastrum coromandelianum* (Linn.) Garcke.

***Malvastrum coromandelianum* (Linn.) Garcke.**

Thai name: Pricly malvastrum, Ya-tevada, Daikhad

Family: Malvaceae

Description: Three-lobe false mallow; the stem is an erect, somewhat hairy, branched, half woody perennial, 1 meter in height or less. The leaves are oblong to ovate-lanceolate, 3-7× 0.8-4 cm, abaxilly pilose and stellate pilose, adaxially sparsely hairy, base broadly cuneate to rounded, margin coarsely dentate, apex acute or obtuse. The flowers are axillary and solitary. The calyx is green, and about 7 mm long, with lanceolate pointed lobes. The petals are yellow, and about 8 mm long, the fruit

consisted of 8 to 12 reniform, compressed, each carpel having 3 short, straight projections [6,29,30].

Chemical constituents and pharmacological investigations

Previous studies found that the water extract from whole plant of *M. coromandelianum* showed strong hypoglycemic activity when given orally. Feeding the crude extract to streptozotocin- induced male wistar rat, the result was found that the extract reduced blood glucose within one hour after administration to a normal level of blood glucose [6]. However, in 2001, Reddy, Venkatesh and Suresh, has reported that the aerial parts of *M. coromandelianum* showed antinociceptive activity in the 0.6% acetic acid-induced writhing test in mice [30].

In 2005, Rattanajarasroj *et al*. is also reported that an oral administration of *M. coromandelianum* extract at dose of 4 g/kg BW showed a significant hypoglycemic effect on alloxan-induced diabetic rat [7]. Moreover Pongpech *et al*., 2005 reported that 25% (w/v) of *M. coromandelianum* in water extraction had inhibitory activity against both methicilin sensitive and methillin resistant *Straphylococcus aureus* by using agar disc diffusion susceptibility test and broth macro dilution test [31].

Traditionally uses: In India, the plants are used for anti-inflammatory agent, analgesics, antidysenterics, jaundice treatment and cleansing ulcers [31].

Antimicrobial susceptibility testing

The primary purpose of antimicrobial susceptibility testing is guide the clinician in the choice of appropriate agents for therapy. In practice, agents are commonly used empirically and the laboratory test serves to explain treatment failures and to provide a range of suitable alternative agents. Routine testing also provide up-to-date accumulated data from which information on the most suitable agents for empirical use can be derived. Apart from routine clinical work, antimicrobial susceptibility tests are used to evaluate the *in vitro* activity of new agents [32].

In vitro antimicrobial susceptibility tests are depended on two roles, diffusion and dilution. Laboratory procedures involving diffusion susceptibility test are commonly performed in agar media called agar diffusion technique.

Agar diffusion susceptibility testing

In general, agar diffusion test are performed by inoculating a nutrient agar medium in a standardized manner and apply the drug to be studied to the agar surface in some type of reservoir. The drug is allowed to diffuse around medium. The tested organism is exposed to a continuous gradient of drug which concentration diminishing as distance from the reservoir increase. After an appropriate period of incubation, there should be a zone of inhibited growth around the reservoir. The size of zone may be measured to determine the degree of susceptibility of test organism [33]. Types of agar diffusion test are classified by the techniques used to apply the solution of antimicrobial agents to a seeded agar medium. Agar disk diffusion method uses filter paper disk that has been moisten with the drug solution and applied directly to the agar while still wet, disc may be prepared more accurately if a micropipette is use to load each disk with a measured volume of drug solution. Besides paper disk, the agar cup method or known as cylinder plate method can also be used. Drug solution is filled into cylinder which placed on agar. This method is applicable to semi solid and liquid samples [34].

Alternatively, agar can be cut from the seeded agar medium by using a cork borer in specified diameters and the agar well is filled with the drug solution. This is called agar well diffusion method.

Broth microdilution method

The method is modification of the broth dilution method by using small volumes for routine testing. The method is performed in microtiter plastic plate containing 96 wells. The advantages are that it utilizes small volumes of reagents and allow a large number of bacterium and fungus [35]. It also includes the generation of MIC, the reproducibility and convenience of having prepared panels, and the

economy of reagents and space that occurs due to the miniaturization of the test [36]. The process is preparing by a serial dilution of drug solutions with a liquid growth medium in a 96 well plates. The wells containing drug solutions are added with a standardized microbial suspension. After the overnight incubation, the wells are examined for visible microbial growth as evidenced by turbidity. The lowest concentration of drug solution that prevents growth represented as the minimal inhibitory concentrations (MIC) [37].

Minimum inhibitory concentration (MIC), minimum bactericidal concentration (MBC) and minimum fungicidal concentration (MFC)

The susceptibility of organisms to serial dilutions of agents in agar or broth is determined. MIC is defined as the lowest concentration of the agents that inhibits visible growth. The most widespread use of MIC method is in testing new agents. In clinical laboratories, MIC method is used to test the susceptibility of organisms which give equivocal results in diffusion tests, for tests on organisms where disc tests may be unreliable, as with slow-growing organisms and when a more accurate result is required for clinical management. Finally, it is necessary to know the minimum concentration of an agent that kills, rather than merely inhibits growth of bacterial and fungal organisms. The minimum bactericidal concentration (MBC) or minimum fungicidal concentration (MFC) is determined by subculturing from tubes showing no turbidity onto antimicrobial agent-free media and observing for growth after further incubation [33,38].

Antimalarial activity

Malaria is parasite disease which caused by a protozoan of the genus *Plasmidium.* Most of the lethal cases are caused by *Plasmodium falciparum*, the most virulent among four Plasmodia species, namely, *Plamodium falciparum, P. vivax, P. malaria* and *P. ovale.* The most dangerous malaria species is *P. falciparum* as it often leads to the death and can be fetal within a few hours of the first symptom.

In general, cultures are synchronized in the laboratory, and the assay will be initiate at the ring stage. Continuous culture of *P. falciparum in vitro* was first obtained by a method providing for slow flow of medium over a thin settled layer of human erythrocytes [39]. This method is a standard method and this will lends itself to partial automation and provides for continues production of parasite material.

The assay of antimalarial activity can be tested on *P. falciparum* clones K1 and 3D7 which is chloroquine resistant and sensitive strain respectively by using 96 well-microplates using SYBR green I based assay. The SYBR green I binds to any double-stranded DNA, preferring G and C base pairs including with the DNA inherently present in whole blood samples. This will result in high background readings. It has been used in molecular biology as substitute for ethidium bromide for several years [40]. This assay is considerably faster, less labor, intensive and less expensive than conventional radiotracer [41].

Antioxidant activity

An antioxidant may be defined as a molecule that inhibits the oxidation of other molecules. Oxidation is a chemical reaction that transfers electron or hydrogen from a substance to an oxidizing agent. Oxidation reactions can produce free radicals. In turn, these radicals can start chain reaction when it is occurs in the cell, this can cause damage or death to the cell. The antioxidants will terminate the chain by removing free radical and inhibit other oxidation reactions. This can happen by being oxidized themselves. For convenience, antioxidants have been traditionally divided into two classes, primary or chain breaking antioxidants and secondary or preventative antioxidants [42]. Secondary or preventative antioxidants are compounds that retard the rate of oxidation. This may be achieved in a number of ways, which including removal of substrate or single oxygen quenching [43].

There are several methods used for estimation of efficiency of synthetic or natural antioxidants, for example ferric reducing antioxidant power (FRAP) assay, *β*-carotene-linoleic acid assays, inhibition of low-density lipoprotein (LDL) oxidation, DPPH assay [44,45].

Antidiabetic potential by *in vitro* alpha-glucosidase and alpha-amylase inhibition testings

Diabetes is a group of metabolic diseases in a person which has high blood sugar, either because the body doesn't produce enough insulin, or because cells do not respond to the insulin that is produced. This high blood sugar will produce the classical symptoms of polyuria, polydipsia and polyphagia.

There are three main types of diabetes mellitius (DM).

- Type 1 DM is the body's failure to produce insulin-dependent diabetes mellitus (IDDM) or "juvenile diabetes".
- Type 2 DM is the result from insulin resistance, a condition in which cells fail to use insulin properly and sometime combined with absolute insulin efficiency. This form was previously referred to as non insulin-dependent diabetes (NIDDM) or "adult-onset diabetes".
- Type 3 DM is gestational diabetes occurs when pregnant women without a previous diagnosis of diabetes develop a high blood glucose level and it may precede development of type 2 DM.

The numbers of individuals diagnosed with type 2 diabetes mellitus are increasing worldwide and this creating a strong demand for the development of more effective anti-diabetic drugs [46,47].

The inhibition of α-glucosidase is one of the powerful interventions coping directly with postprandial hyperglycemia. The α-glucosidases are two enzyme complexes in the brush border of small intestine those breakdown oligosaccharides to absorbable glucose. The synthetic or natural α-glucosidase inhibitors are of therapeutic interest to delay postprandial hyperglycemia in Type 2 diabetes [48,49]. The α-glucosidase inhibiting activity is due to the substrate mimetic structure of these drugs, such as Acarbose, Miglitol, Voglibose, Nojirimycin and 1-Deoxynojirimycin (Figure 4).

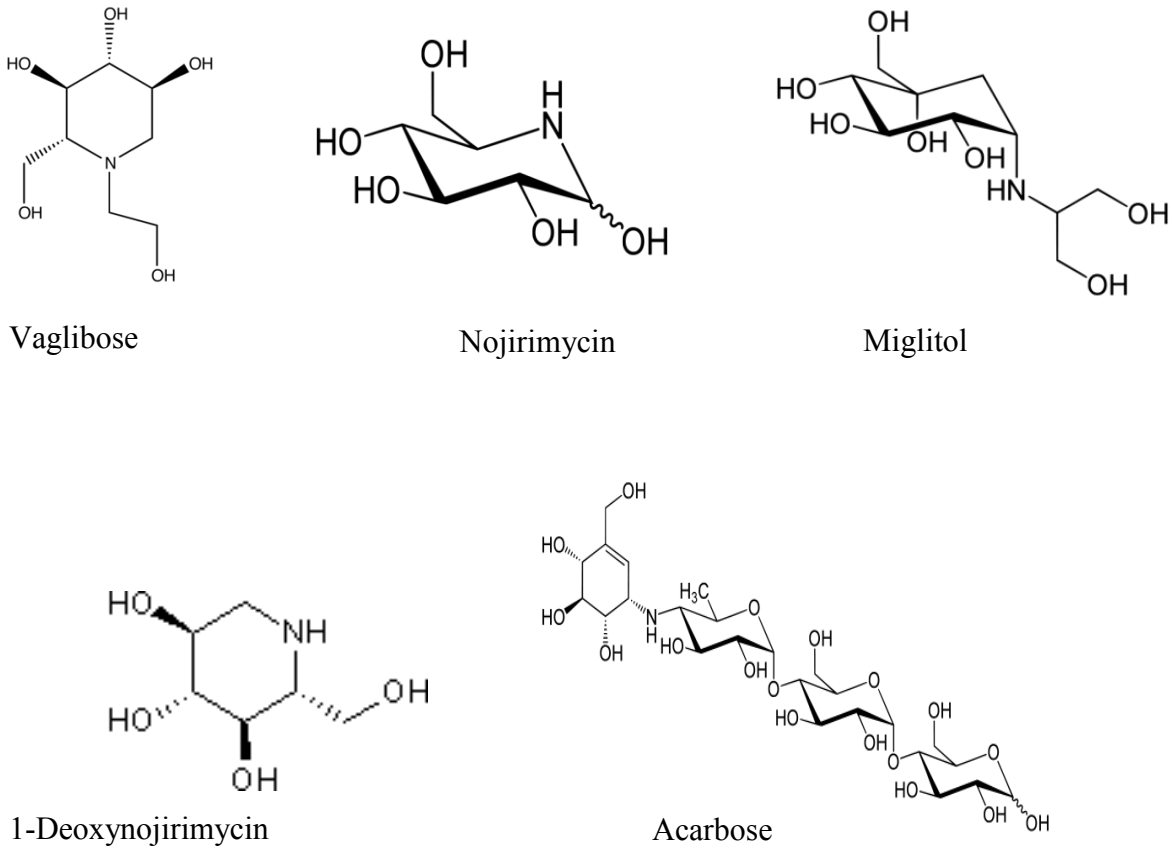

Figure 4. α-glucosidase inhibitors [50]

The benefit of α-glucosidase inhibition in accordance with a reduction in diabetic complications especially cardiovascular symptoms has been reported and these inhibitors have been recommended for pre-diabetic as well as antidiabetic agents [51,52].

The sucrose-isomaltase complexes of mammalian intestinal extract have been classified as a kind of α-glucosidase and it have been involved in digestion of carbohydrates and resultantly, increasing the blood glucose level. Therefore, inhibitors of this mammalian intestinal α-glucosidase have become stimulating choices to slow down the digestion of carbohydrates and in turn mitigate post-prandial hyperglycemic excursions [53]. Furthermore, α-glucosidase inhibitor also offer other benefits which are, reducing triglycerides level and post prandial insulin levels [54].

Alpha-amylase is an enzyme which aims to breakdown of starch to maltose. It hydrolyzes bonds between glucose repeats. Amylase inhibitors are starch blockers that contain substances which can prevent dietary carbohydrates from being absorbed by the body. Starches are complex carbohydrates that can't be absorbed unless they are first broken down by the digestive enzyme amylase and other secondary enzymes. This could be useful in the treatment of obesity and diabetes mellitus [55].

The α-amylase constitute a family of endo-amylase that catalyses the initial hydrolysis of starch into shorter oligosaccharides through the cleavage of α-D-(1-4) glycosidic bonds [56]. There are variety of plants have been reported to show α-amylase inhibitory activity and relevant to the treatment of type 2 diabetes. A wide range of plant-derived principles belonging to compounds such as alkaloids, glycosides, galactomannan gum, polysaccharides, hypoglycans, peptidoglycans, guanidine, steroids, glycopeptides and tepenoids have demonstrated bioactivity against hyperglycemia [57].

Cytotoxic activity testing using brine shrimp method

Brine shrimp (*Artemia salina*) method has been used as "bench top bioassay" for the investigation of bioactive natural product. It is a good choice for elementary toxicity investigation of consumer products, despite *Artemia* is too robust to be a sensitive indicator species [58]. The brine shrimp lethality assay was proposed by Michale *et al*, 1992. and later developed by Vanchaecke *et al* 1981. The assay is based on the ability to kill laboratory-cultured *Artemia* nauplii brine shrimp [59].

Brine shrimp is a species of aquatic crustaceans of genus *Artemia.* The body is divided into head, thorax, and abdomen. The entire body is covered with a thin, flexible exoskeleton of chitin to which muscles are attached internally and shed periodically. The brine shrimp have a simple life cycle that is very well suited for the environment that they live in. Female *Artemia* molting precedes every ovulation. It ovulates approximately every 140 hours. The eggs can immediately hatch or lie dormant with a chorion brown coating, known as cysts, due to their environmental condition. After hatching from the cysts, brine shrimps grow extremely fast. As juveniles, they possess only one eye, but as adults they develop two eyes.

Toxicity study put confidence to the potential treatment or drugs and has become a part of pharmacological evaluation to corroborate the employment of medicinal plants in ethnomedical practices. In many toxicological studies, brine shrimp assay has been a complimentary assay to other toxicity assays [59,60].

CHAPTER III

MATERIALS AND METHODS

Chemicals Materials

1. 1-Deoxynojirimycin (Sigma-Aldrich, USA)
2. 2-Chloro-4-Nitrophenol α-D-Maltotrioside (Sigma-Aldrich, USA)
3. *Artemia salina* (Local pet shop at Chatuchak market, Thailand)
4. Alpha-glucosidase from *Saccharomyces cerevisiae* (Sigma-Aldrich, USA)
5. Alpha-glucosidase from Rat intestinal intestine (Sigma-Aldrich, USA)
6. Alpha –amylase (Sigma-Aldrich, USA)
7. Acarbose (Sigma-Aldrich, USA)
8. Acetic acid (Analyrical grade, B.H. Chemicals, England)
9. Ampicillin sodium (T.P. Drug Laboratories (1996) Co., Ltd., Thailand)
10. Amikacin sulfate (T.P. Drug Laboratories (1996) Co., Ltd., Thailand)
11. Dimethyl sulfoxide (Merck, Germany)
12. Ferric chloride (Ajax, Finechem Pty., Ltd., New Zealand)
13. Ferrozine (Sigma-Aldrich, USA)
14. Mueller Hinton agar and broth (Merck, Germany)
15. p-nitrophenyl-α-D-glucopyranoside (Sigma-Aldrich, USA)
16. Potassium ferricyanide (Sigma-Aldrich, USA)
17. Sabouraud Dextrose agar and broth (Merck, Germany)
18. Sodium nitroprusside (Sigma-Aldrich, USA)
19. Sulfanilamide (Sigma-Aldrich, USA)
20. Quercetin (Sigma-Aldrich, USA)
21. Ascorbic acids (Merck, Germany)
22. All other chemicals were analytical grade.

Equipments and instruments

1. Autoclave (ALP Co., Ltd, Japan)
2. Corck borer
3. Cuvette (Barloworld Scientific Ltd., Staffordshrine, United Kingdom)
4. Digital balance (SI-234, Denver instruments, Bohemia, New York, USA)
5. Filter paper No.4 (Whatman, England)
6. Hot air oven (WTB binder, Germany)
7. Lamina hood (Astec SC1200 AC, Bioquell UK Ltd., United Kingdom)
8. Micro centrifuge (Mistral 3000,Thai polymedic Co., Ltd)
9. Microplate reader (ASYS UVM340, Biochrom Ltd., United Kingdom)
10. Microplate with 96 wells (Costar, USA)
11. Rotary evaporation (Buchi R210, Switzerland)
12. Soxhlet apparatus
13. Spectrophotometer (Shimadzu-W 1800, Shimadzu corp., Japan)
14. Ultrasonic sonicator (Analytical Lab Science Co., Ltd., Thailand)
15. Water bath

Methods

Plant Materials

Different plant parts (roots, leaves, and stems) of *S. acuta*, *M. coromandelianum* and *A. indicum* were collected. The plants were authenticated by Assoc. Prof. Nijsiri Ruangrungsi, Ph.D. Voucher specimens were deposited at College of Public Health Sciences, Chulalongkorn University, Thailand.

Plant extracts

All the plant materials were dried in hot air oven at 50°C and ground–to coarse powder. Each dried powder was exhaustively extracted with dichloromethane and methanol respectively by Soxhlet apparatus. The extracts were filtered through Whatman number 1 filter paper then evaporated to dryness *in vacuo*. The yields were weighed, and stored at -20 ^{o} C for further uses.

Alkaloid extracts

Three-hundred grams of dried powder of *S. acuta* whole plants was continuously macerated with 95% ethanol until it was exhausted. The ethanol was filtered and the filtrates of maceration were combined. The combined filtrate was concentrated under reduced pressure to syrupy mass. The syrupy mass was dissolved in 7% sulfuric acid and filtered. The acid solution was adjusted to alkaline pH with ammonia solution and followed by extraction with dichloromethane. The base was extracted with dichloromethane until it was exhausted. Finally, dichloromethane was totally evaporated to form the alkaloid extract.

Antimicrobial activities testing

Microorganisms

The microorganisms used as the tested organisms, included gram-positive bacteria, gram-negative bacteria, spore forming bacteria and fungi. (Table 1)

Table 1. Tested microorganisms

Microorganism	
Gram positive bacteria (Non-spore forming bacteria)	*Staphylococcus aureus* ATCC6538P[1] *Micrococcus luteus* ATCC9341[2] *Staphylococcus epidermidis* (Isolates)[3]
Gram positive bacteria (Spore forming bacteria)	*Bacillus subtilis* ATCC6633[1] *Basillus cereus* ATCC11778[2]
Gram negative bacteria (Non-spore forming bacteria)	*Escherichia coli* ATCC25922[1] *Enterobacter aerogenes* ATCC13048[2] *Pseudomonas aeruginasa* ATCC9027[1] *Salmonella typhi* (Isolates)[3] *Salmonella typhimurium* ATCC13311[3] *Shigella* spp (Isolates)[3]
Fungi	*Candida albicans* ATCC10230[1] *Saccharomyces cerevisiae* ATCC9763[1]

Sources: [1]Department of Biochemistry and Microbiology, Faculty of Phamaceutical Sciences, Chulalongkorn University

[2]Department of Microbiology, Faculty of Sciences and Technology, Suan Sunandha Rajabhat University

[3]Department of Microbiology, Faculty of Sciences, Chulalongkorn University

Preparation of the inocolum

Bacterial and Fungal strains were maintained on Mueller Hinton agar (MHA) and Sabouraud Dextose agar (SDA) respectively. They were inoculated at 37^{o} C for 18-24 hours for bacteria and 24-48 hours for fungi. The cultures were suspended in sterile 0.85% NaCl and the turbidity of suspension was measured by spectrophotometer at 625 nm to obtain the absorbance of 0.08-0.10 which equivalent to 0.5 McFarland standards (approximately 1×10^{8} CFU/ml)

Determination of zone inhibition

Modified agar well diffusion method using a two-layer agar technique was used [61-63]. One hundred microlitres of the suspension was mixed with 3 ml of sterile seeds agar and poured to sterile base agar. The plates were allowed to dry at room temperature. Agar wells were performed by a cork borer (6 mm) [64-65].

Twenty microlitres of 200 mg/ml in dimethyl sulfoxide (DMSO) of *S. acuta* extracts were added to each well. Ampicillin and amikacin (1 mg/ml, 20 µl) were used as positive control and DMSO (20 µl) was used as a negative control. The plates were incubated at 37^{o} C for 18 to 24 hours and 24 to 48 hours for bacterial and fungal strains respectively. The antimicrobial activity was evaluated by measuring the diameters of inhibition zone (in millimeters). Each extract was tested in triplicate.

Determination of the minimum inhibitory concentration (MIC), minimum bactericidal concentration (MBC) and minimum fungicidal concentration (MFC)

The assay was performed in a sterile 96-well microplate according to Rios and Recio (2005) [64] with modification. A microbial suspension was prepared by adding 10 µl of 0.85% normal saline microbial suspensions to 1 ml of Muller-Hinton or Sabouraud broth.

S. acuta extracts which showed inhibition zone were serially diluted in DMSO. Fifty microlitres of 0.5 McFarland microbial suspension in broth was added to each well containing 50 µl of extracts / positive control / negative control (DMSO) and incubated at 37°C for 18-24 hours (for bacteria) or 24 to 48 hours (for fungi). The

least concentration of each extract which showed a growth inhibition detected by the lack of visual turbidity compared to the negative control was taken as the MIC. The broth from the wells without turbidity were streaked onto the agar plates and incubated at 37°C, for 18 to 24 hours (for bacterial) or 24-48 hours (for fungi). The least concentration with no growth of microbes was considered as MBC or MFC.

Antimalarial activity testing

The *in vitro* antimalarial activities of *S. acuta* and alkaloid extracts against *P. falciparum* clones K1 and 3D7 were performed in 96-well microtiter plates using SYBR green-I-based assay [67]. Parasites were maintained in continuous culture in human erythrocytes suspended in RPMI 1640 culture medium supplemented with 10% human B serum and 25 mM HEPES (at 37°C under a gas mixture of 5% CO_2, 5% O_2, and 90% N_2) according to the standard method (Trager and Jensen 1976) [67,68]. Highly synchronous ring stage parasite was used in each assay. Fifty microlitres of parasite inoculum with 2% parasitemia and 1% hematocrit, was added into each well of microtiter plate. The 96-well drug plates were dosed with tested extracts at a total of eight final concentrations (0-100 µg/ml of 50% ethanol). After 2 days incubation, 100 µl of SYBR Green I in lysis buffer was added to each well and incubated for 1 hour in the dark. Then fluorescence was measured at 485 nm excitation and 530 nm emission [68]. All extracts were analysed in triplicate and the percent inhibition was calculated by the following formula:

$$\% \text{ Inhibition} = 1 - \frac{\text{emission intensity of extract}}{\text{emission intensity of negative control}} \times 100$$

Yeast alpha-glucosidase inhibition testing

The activity of alpha-glucosidase from *Saccharomyces cere*visiae was assayed using 1 mM of p-nitrophenyl-α-D-glucopyranosiade as substrate [69]. *S. acuta*, *M. coromandelianum* and *A. indicum* extract solutions were prepared in 10% DMSO to obtain different concentrations in range of 0.625-10 mg/ml. In 96 well plate, 50 µl of the extracts were added into 50 µl of 0.1M sodium phosphate buffer, pH 6.9 and 50 µl of 0.5 U/ml α-glucosidase. The plates were incubated at 37°c for 10 minutes. Next, 50

µl of substrate were added and incubated again at 37°C for 20 minutes. The reaction was terminated by adding 100 µl of 1M Na_2CO_3 and the absorbance was measured at 405 nm using microplate reader. All extracts were analysed in triplicate. 1-Deoxynojirimycin was used as the positive control. The percent inhibition was calculated by the following formula:

$$\% \text{ Inhibition} = 1 - \frac{\text{absorbance intensity of extract}}{\text{absorbance intensity of negative control}} \times 100$$

Rat alpha-glucosidase inhibition testing

The activity of plant extracts against rat intestinal alpha-glucosidase was determined by the method of Yamaki and Mori (2006) with modification [70]. The assay was performed on 96 well plates using 1 mM of p-nitrophenyl-α-D-glucopyranosiade as substrate. *S. acuta*, *M, coromandelianum* and *A. indicum* extract solutions were prepared in 10% DMSO and diluted with distilled water to obtain different concentrations in range of 0.625-10 mg/ml and 50 µl of the extracts were added into 100 µl of 1 mM of p-nitrophenyl-α-D-glucopyranosiade. Rat intestinal acetone powder (30 mg/ml in 0.1M sodium phosphate buffer pH 6.9) was sonicated for 20 min. The suspension was centrifuged at 3000 rpm for 30 min to remove particulate matter. The resulting supernatant was used as α-glucosidase. The reaction was initated by addition 50 µl of the enzyme. The plate was incubated for 30 min at 37°C. The absorbance was measured at 405 nm using microplate reader. All extracts were analyzed in triplicate. 1-Deoxynojirimycin was used as the positive control. The percent inhibition was calculated by the following formula:

$$\% \text{ Inhibition} = 1 - \frac{\text{absorbance intensity of extract}}{\text{absorbance intensity of negative control}} \times 100$$

Pancreatic alpha - amylase inhibition activity

The activity of pancreatic α-amylase inhibition was performed as described by Gella *et al* [71] with modification. The assay was performed on 96 well plates using 2- chloro-4 nitrophenol-α-D-maltotroside (CNPG-3) as substrate. *S. acuta*, *M. coromandelianum* and *A. indicum* extracts were prepared in 10% DMSO and diluted with distilled water to obtain concentration between 0.625-10 mg/ml and 50 µl of the extracts were added in to 0.5 µl of 0.5 U/ml of pancreatic α-amylase prepared in 0.1 sodium phosphate buffer pH 6.9. The plate was preincubated at room temperature for 10 minutes and 50 µl of substrate were added into each well and incubated at 37°C for 10 minutes. The absorbance was measured at 405 nm using microplate reader. All extracts were tested in triplicate. Acarbose was used as positive control. The percent inhibition was calculated by the following formula:

$$\% \text{ Inhibition} = 1 - \frac{\text{absorbance intensity of extract}}{\text{absorbance intensity of negative control}} \times 100$$

Antioxidation activity testing

DPPH radical scavenging assay

The activity was determined according to method of Brand-William *et al*. [72] with some modifications. The assays were carry out in a 96 well microplate with each concentration performed in triplicate. Aliquot of 100 µl of DPPH solution in methanol (126 µM) was pipetted into 96 well microplate, followed by 100 µl of *S. acuta* extract or ascorbic acids (as positive control) prepared in methanol. The reaction was allowed to incubate for 30 minutes at room temperature and the absorbance of mixture was measured at 517 nm using microplate reader. The DPPH radical scavenging activity was calculated according to the following equation:

$$\% \text{ Scavenging effect} = 1 - \frac{\text{absorbance intensitv of extract}}{\text{absorbance intensity of control}} \times 100$$

Reducing power capacity

The assay was carrying out in 96 well microplate with each concentration performed in triplicate. One milligrams of *S. acuta* extracts were dissolved in 1 milliliter of distilled water and diluted with 0.1 M phosphate buffer (pH 6.6) to obtain different concentrations in range of 0.02 to 1.0 mg/ml. A 148 µl of each concentration was pipetted into 96-well microplate, followed by 50 µl of 1% potassium ferricyanide (w/v). The plate was incubated at 50°C for 20 min. Next, 50 µl of 10% tricloroacetic acid (w/v) and 10 µl of 1% ferric chloride (w/v) were added into each well. The plate was mixed well then measured the absorbance at 700 nm by microplate reader. BHT and Quercetin were used as positive control. The reducing activity was evaluated from the calibration curve of ferric chloride.

Metal chelating activity

The assay was carried out in cuvette. The extracts of *S. acuta* (5 mg/ml) were prepared in ultrapure water and 500 µl of extracts at various concentrations were added to cuvette with 25 µl of 2 mM $FeCl_2$ in ultrapure water and read the absorbance at 562 nm. The reaction was started by addition of 50 µl of 5 mM aqueous ferrozine. The mixture was left for 5 minutes. The absorbance of reaction was measured at 562 nm by spectrophotometer. EDTA was used as positive control. Chelating activity was calculated as the following equation:

$$\text{Metal chelating activity (\%)} = [(A_{control} - A_{sample}) / A_{control}] \times 100$$

Where, A_{sample} is the absorbance values measured end time of the incubation for test sample. $A_{control}$ is the absorbance measured at end time of the incubation for control, respectively.

Nitric oxide scavenging assay

Five milligrams of *S. acuta* extracts were dissolved in 1 ml of ultrapure water and diluted to obtain different concentrations in a range of 0.05-5 mg/ml. The assay was carried out in cuvette. Four hundred microlitres of extract or control were added into 400 µl of 5 mM aqueous sodium nitroperusside. The mixture was measured at 540 nm, incubated for 2 hours, and 800 µl of Griess reagent (0.5% sulphanilamide in ultrapure water, 0.16% napthylethylendiamine dihydrochloride in 20% acetic acid, 1:1) was added and immediately read at 540 nm by spectrophotometer. Quercetin was used as positive control. The nitric oxide scavenging activity was calculated as the following equation:

$$\text{Nitric oxide scavenging activity (\%)} = [(A_{control} - A_{sample}) / A_{control}] \times 100$$

Where, A_{sample} is the absorbance values measured end time of the incubation for test sample. $A_{control}$ is the absorbance measured at end time of the incubation for control, respectively.

Cytotoxic activity testing

Brine shrimp lethality assay

Artificial sea water was prepared by dissolving 3.8 g sea salt per liters of water and aerated for 24 hours. Fresh eggs of *A. salina* were hatched in artificial sea water and after 48 hours of incubation, ten brine shrimps were transferred to each sample vial and artificial sea water was added to make 5 ml. Filter papers impregnated with extracts at the concentration of 9000, 7000, 5000, 4000, 3000, 2000 and 1000 µg/ml in methanol were air dried before placed into each vials containing the brine shrimps. Methanol was used as positive control and five replicates were prepared for each concentration. The vials were maintained under illumination. Every six hours, eleven hours and twenty-four hours later, the number of survivors was counted, recorded and concentration which caused 50% of brine shrimp lethality (LC_{50} value) was obtained from a plot of percentage of the brine shrimp nauplii killed against the concentrations of the extracts.

CHAPTER IV

RESULTS

Plant extracts

The fractional extracts of three selected malvacevous plants were performed by dichloromethane and methanol respectively. The percent yields were shown in Table 2.

Table 2 Extract yield from selected malvaceous plants

Plant	Part used	Yield (%W/W)	
		Dichloromethane fraction	Methanolic fraction
Sida acuta Burm.f	Stems	3.93	12.55
	Roots	1.46	4.62
	Leaves	1.65	21.43
Abutilon indicum (Linn) Sweet.	Stems	1.34	8.20
	Roots	3.07	25.90
	Leaves	1.60	15.40
Malvastrum coromandelianum (L.) Garcke.	Stems	3.50	13.15
	Roots	3.48	13.00
	Leaves	9.08	24.12

Antimicrobial activities

The antimicrobial potential among *S. acuta* extracts were determined *in vitro*. The ability of stems, roots and leaves of *S. acuta* and antibiotic drugs to inhibit the growth of selected bacterial and fungal strains was evaluated by modified agar well diffusion method using a two layer agar technique against 13 species of microorganism which were 5 species of gram positive bacteria, 6 species of gram negative bacteria and 2 species of fungi. The extracts and antibiotic showing inhibition zone were further evaluated for MIC, MBC and MFC respectively.

The antimicrobial activities at the concentrations of 4 mg/well of the extracts and 20 µg /well of positive controls were shown as mean ±SD of inhibition zone (Table 3-15). The results from various parts of plant demonstrated different antimicrobial effect.

All of the extracts from stems, roots and leaves of *S. acuta* showed antibacterial activity against *Bacillus cereus*. The methanolic extracts of leaves presented highest potential activity with the inhibition zone of MIC and MBC of 500 µg/ml (Table 3).

Only dichloromethane extracts of leaves, methanolic extracts of stems and leaves of *S. acuta* inhibited *Bacillus subtilis* growth. The highest potential was from the methanolic extract of leaves with MIC and MBC of 500 µg/ml (Table 4).

Table 3 Antimicrobial activity of *S. acuta* extracts against *Basillus cereus*

Solvents extract	Plant part	*Basillus cereus*		
		Inhibition zone (mm)	MIC (µg/ml)	MBC (µg/ml)
Dichloromethane fraction	Stems	11.7±0.6	>2000	>2000
	Roots	8.0±1.0	>2000	>2000
	Leaves	12.3±1.5	1000	1000
Methanolic fraction	Stems	14.3±0.6	>2000	>2000
	Roots	10.3±0.6	>2000	>2000
	Leaves	27.7±2.1	500	500
Positive control				
Ampicillin sodium		37.7±0.6	0.19	0.19
Amikacin sulfate		23.7±2.1	0.39	0.30
Negative control				
DMSO		NA	NA	NA

*****Data±SD, NA = no activity, diameter of well = 6 mm. The extracts were tested in triplicate

Table 4 Antimicrobial activity of *S. acuta* extracts against *Basillus subtilis*

Solvents extract	Plant part	*Basillus subtilis*		
		Inhibition zone (mm)	MIC (µg/ml)	MBC (µg/ml)
Dichloromethane fraction	Stems	NA	NA	NA
	Roots	NA	NA	NA
	Leaves	10.3±0.6	1000	2000
Methanolic fraction	Stems	14.3±0.6	>2000	>2000
	Roots	NA	NA	NA
	Leaves	13.3±0.6	500	500
Positive control				
Ampicillin sodium		16.0±1.0	12.50	12.50
Amikacin sulfate		26.3±0.6	0.19	0.39
Negative control				
DMSO		NA	NA	NA

*****Data±SD, NA = no activity, diameter of well = 6 mm. The extracts were tested in triplicate

For *Staphylococcus aureus* inhibition, the methanolic extracts of leaves showed strongest antibacterial activity (16.7±0.6 mm). Moreover, the results showed that the methanolic extracts of leaves presented potent bactericidal activity on *Staphylococcus aureus* with the MBC and MIC of 250 µg/ml. The results were shown in Table 5.

Table 5 Antimicrobial activity of *S. acuta* extracts against *Staphylococcus aureus*

Solvents extract	Plant part	*Staphylococcus aureus*		
		Inhibition zone (mm)	MIC (µg/ml)	MBC (µg/ml)
Dichloromethane fraction	Stems	NA	NA	NA
	Roots	NA	NA	NA
	Leaves	10.3±0.6	2000	>2000
Methanolic fraction	Stems	14.7±0.6	500	1000
	Roots	NA	NA	NA
	Leaves	16.7±0.6	250	250
Positive control				
Ampicillin sodium		50.7±1.2	0.19	6.25
Amikacin sulfate		19.0±0.0	1.56	3.12
Negative control				
DMSO		NA	NA	NA

*****Data±SD, NA = no activity, diameter of well = 6 mm. The extracts were tested in triplicate

Most of the extracts exhibited *Staphylococcus epidermidis* except for the dichloromethane extracts of roots and leaves. The methanolic extracts of stems exhibited potent growth inhibition (MIC= 250 µg/ml and MBC= 500 µg/ml). The results were shown in Table 6.

Table 6 Antimicrobial activity of *S. acuta* extracts against *Staphylococcus epidermidis*

Solvents extract	Plant part	*Staphylococcus epidermidis*		
		Inhibition zone (mm)	MIC (µg/ml)	MBC (µg/ml)
Dichloromethane fraction	Stems	9.3±0.6	>2000	>2000
	Roots	NA	NA	NA
	Leaves	NA	NA	NA
Methanolic fraction	Stems	16.3±0.6	250	500
	Roots	10.0±1.0	2000	>2000
	Leaves	12.7±0.6	500	1000
Positive control				
Ampicillin sodium		29.3±0.6	0.78	0.78
Amikacin sulfate		21.0±1.0	0.78	1.56
Negative control				
DMSO		NA	NA	NA

*****Data±SD, NA = no activity, diameter of well = 6 mm. The extracts were tested in triplicate

All of the extracts demonstrated antimicrobial property against *Micrococcus luteus*. The methanolic extracts of stems presented highest potent activity (inhibition zone = 14.3±0.6 mm, MIC= 250 µg/ml and MBC= 500 µg/ml). The methanolic extracts from roots showed weakest antimicrobial activity with the inhibition zone of 8.7±0.6 mm, MIC and MBC of >2000 µg/ml. The results were shown in Table 7.

There were only dichloromethane and methanolic extracts of stems showed antibacterial activity against *Escherichia coli*. The results showed marginal potential against *Escherichia coli* with the inhibition zone around 10-13 mm. The MIC and MBC of the extract were more than 2000 µg/ml. The results were demonstrated in Table 8.

Table 7 Antimicrobial activity of *S. acuta* extracts against *Micrococcus luteus*

Solvents extract	Plant part	*Micrococus luteus*		
		Inhibition zone (mm)	MIC (µg/ml)	MBC (µg/ml)
Dichloromethane fraction	Stems	10.6±1.2	1000	2000
	Roots	11.0±1.0	500	1000
	Leaves	11.0±1.0	500	500
Methanolic fraction	Stems	14.3±0.6	250	500
	Roots	8.7±0.6	>2000	>2000
	Leaves	12.3±0.6	500	1000
Positive control				
Ampicillin sodium		52.7±0.6	0.19	0.39
Amikacin sulfate		19.0±0.0	0.78	1.56
Negative control				
DMSO		NA	NA	NA

*****Data±SD, NA = no activity, diameter of well = 6 mm. The extracts were tested in triplicate

Table 8 Antimicrobial activity of *S. acuta* extracts against *Escherichia coli*

Solvents extract	Plant part	*Escherichia coli*		
		Inhibition zone (mm)	MIC (µg/ml)	MBC (µg/ml)
Dichloromethane fraction	Stems	10.0±0.0	>2000	>2000
	Roots	NA	NA	NA
	Leaves	NA	NA	NA
Methanolic fraction	Stems	13.3±1.0	>2000	>2000
	Roots	NA	NA	NA
	Leaves	NA	NA	NA
Positive control				
Ampicillin sodium		32.0±0.0	3.12	3.12
Amikacin sulfate		24.3±0.6	0.78	1.56
Negative control				
DMSO		NA	NA	NA

*****Data±SD, NA = no activity, diameter of well = 6 mm. The extracts were tested in triplicate

For *Enterobacter aerogenes* and *Pseudomonas aeruginosa*, there was only the methanolic extract of leaves possessed the inhibitory activity. They presented the inhibition zone of 13.3±0.6 mm, MIC and MBC >2000 µg/ml against *Enterobacter aerogenes* and inhibition zone of 10.7±0.6 mm against *Pseudomonas aeruginosa* with MIC of 1000 µg/ml and MBC >2000 µg/ml. The results were shown in table 9 and 10 respectively.

The dichloromethane extract of stems and methanolic extracts of stems and roots of *S. acuta* exhibited bactericidal property on *Salmonella typhi* with the MIC and MBC more than 2000 µg/ml. The results were demonstrated in table 11.

Table 9 Antimicrobial activity of *S. acuta* extracts against *Enterobacter aerogenes*

Solvents extract	Plant part	*Enterobacter aerogenes*		
		Inhibition zone (mm)	MIC (µg/ml)	MBC (µg/ml)
Dichloromethane fraction	Stems	NA	NA	NA
	Roots	NA	NA	NA
	Leaves	NA	NA	NA
Methanolic fraction	Stems	NA	NA	NA
	Roots	NA	NA	NA
	Leaves	13.3±0.6	>2000	>2000
Positive control				
Ampicillin sodium		18.7±0.6	100	100
Amikacin sulfate		20.3±0.6	0.78	1.56
Negative control				
DMSO		NA	NA	NA

*****Data±SD, NA = no activity, diameter of well = 6 mm. The extracts were tested in triplicate

Table 10 Antimicrobial activity of *S. acuta* extracts against *Pseudomonas aeruginosa*

Solvents extract	Plant part	*Pseudomonas aeruginosa*		
		Inhibition zone (mm)	MIC (µg/ml)	MBC (µg/ml)
Dichloromethane fraction	Stems	NA	NA	NA
	Roots	NA	NA	NA
	Leaves	NA	NA	NA
Methanolic fraction	Stems	NA	NA	NA
	Roots	NA	NA	NA
	Leaves	10.7±0.6	1000	>2000
Positive control				
Ampicillin sodium		NA	NA	NA
Amikacin sulfate		16.3±2.1	0.78	1.56
Negative control				
DMSO		NA	NA	NA

*****Data±SD, NA = no activity, diameter of well = 6 mm. The extracts were tested in triplicate

Table 11 Antimicrobial activity of *S. acuta* extracts against *Salmonella typhi*

Solvents extract	Plant part	*Salmonella typhi*		
		Inhibition zone (mm)	MIC (µg/ml)	MBC (µg/ml)
Dichloromethane fraction	Stems	10.3±0.6	>2000	>2000
	Roots	NA	NA	NA
	Leaves	NA	NA	NA
Methanolic fraction	Stems	14.3±1.5	>2000	>2000
	Roots	9.7±0.6	>2000	>2000
	Leaves	NA	NA	NA
Positive control				
Ampicillin sodium		34.3±0.6	1.56	1.56
Amikacin sulfate		22.2±2.0	0.78	0.78
Negative control				
DMSO		NA	NA	NA

*****Data±SD, NA = no activity, diameter of well = 6 mm. The extracts were tested in triplicate

For inhibition against *Salmonella typhimurium,* the methanolic extract of stems showed strongest inhibition zone than those of dichloromethane extract of stems and methanolic extract of roots. However all extracts showed marginal potential of which the MIC and MBC were more than 2000 µg/ml. The results were demonstrated in table 12.

All of the extracts except dichloromethane of root and leaves of *S. acuta* showed inhibitory action against *Shigella sp.* The methanolic extracts of leaves expressed potent inhibition with the inhibition zone of 30.3±0.6 mm and the MIC and MBC of 250 µg/ml and 500 µg/ml respectively. The results were shown in table 13.

Table 12 Antimicrobial activity of *S. acuta* extracts against *Salmonella typhimurium.*

Solvents extract	Plant part	*Salmonella typhimurium.*		
		Inhibition zone (mm)	MIC (µg/ml)	MBC (µg/ml)
Dichloromethane fraction	Stems	10.0±0.6	>2000	>2000
	Roots	NA	NA	NA
	Leaves	NA	NA	NA
Methanolic fraction	Stems	14.7±0.6	>2000	>2000
	Roots	10.0±0.0	>2000	>2000
	Leaves	NA	NA	NA
Positive control				
Ampicillin sodium		35.7±0.6	0.39	0.78
Amikacin sulfate		27.7±1.6	0.78	0.78
Negative control				
DMSO		NA	NA	NA

*****Data±SD, NA = no activity, diameter of well = 6 mm. The extracts were tested in triplicate

Table 13 Antimicrobial activity of *S. acuta* extracts against *Shigella sp.*

Solvents extract	Plant part	*Shigella sp.*		
		Inhibition zone (mm)	MIC (µg/ml)	MBC (µg/ml)
Dichloromethane fraction	Stems	10.0±1.0	1000	>2000
	Roots	NA	NA	NA
	Leaves	NA	NA	NA
Methanolic fraction	Stems	14.7±0.6	500	1000
	Roots	10.7±1.0	2000	2000
	Leaves	30.3±0.6	250	500
Positive control				
Ampicillin sodium		32.0±0.0	3.12	6.25
Amikacin sulfate		28.0±0.0	0.78	1.56
Negative control				
DMSO		NA	NA	NA

*****Data±SD, NA = no activity, diameter of well = 6 mm. The extracts were tested in triplicate

The antifungal activities were performed against *Candida albicans* and *Saccharomyces cerevisiae.* Among 6 crude extracts, 2 extracts were marginally active against *Candida albicans* (MIC and MFC 2000 µg/ml). The dichloromethane extract of roots was more potent than dichloromethane extract of stems. The results were shown in table 14.

Dichloromethane extracts of stems and methanolic extract of roots and leaves of *S. acuta* showed high potency against *Saccharomyces cerevisiae* (inhibition zone ≥ 20 mm). The dichloromethane extract of stems presented high potential against *Saccharomyces cerevisiae* with the inhibition zone of 32.7±0.6 mm. The MIC and MFC of these extracts were 125 µg/ml and 500 µg/ml respectively. The results were shown in table 15.

Table 14 Antimicrobial activity of *S. acuta* extracts against *Candida albicans*

Solvents extract	Plant part	*Candida albicans*		
		Inhibition zone (mm)	MIC (µg/ml)	MFC (µg/ml)
Dichloromethane fraction	Stems	11.0±1.0	2000	2000
	Roots	13.7±0.6	2000	2000
	Leaves	NA	NA	NA
Methanolic fraction	Stems	NA	NA	NA
	Roots	NA	NA	NA
	Leaves	NA	NA	NA
Positive control				
Ampicillin sodium		NA	NA	NA
Amikacin sulfate		NA	NA	NA
Negative control				
DMSO		NA	NA	NA

*****Data±SD, NA = no activity, diameter of well = 6 mm. The extracts were tested in triplicate

Table 15 Antimicrobial activity of *S. acuta* extracts against *Saccharomyces cerevisiae.*

Solvents extract	Plant part	*Saccharomyces cerevisiae*		
		Inhibition zone (mm)	MIC (µg/ml)	MFC (µg/ml)
Dichloromethane fraction	Stems	32.7±0.6	125	500
	Roots	NA	NA	NA
	Leaves	NA	NA	NA
Methanolic fraction	Stems	NA	NA	NA
	Roots	20.7±1.2	250	500
	Leaves	26.7±1.2	125	500
Positive control				
Ampicillin sodium		NA	NA	NA
Amikacin sulfate		NA	NA	NA
Negative control				
DMSO		NA	NA	NA

*****Data±SD, NA = no activity, diameter of well = 6 mm. The extracts were tested in triplicate

Antimalarial activities

The ability of antimalarial activities of *S. acuta* crude extracts and alkaloid extract against K1 chloroquine resistant *P. falciparum* clones and 3D7 chloroquine sensitive *P. falciparum* are presented in Table 16. The methanolic extract of leaves and alkaloid extract of *S. acuta* showed promising antimalarial activity on both clones with the IC_{50} of 4.6, 4.0, 6.26 and 9.36 µg/ml respectively. One hundred micromolars of dihydroartemisinin (DHA) as positive control showed 100% inhibition.

Table 16 IC_{50} of *S. acuta* and alkaloid extracts against *Plasmodium falciparum* strains K1 and 3D7

S. acuta extract	Plant part	IC_{50} (µg/ml)	
		K1	3D7
Dichloromethane fraction	Stems	>50.0	>50.0
	Roots	41.6	23.7
	Leaves	>50	>50
Methanolic fraction	Stems	22.1	18.9
	Roots	>50.0	>50.0
	Leaves	4.6	4.0
Alkaloid		6.26	9.36

*The extracts were tested in triplicate.

Yeast alpha-glucosidase inhibition activity

The alpha-glucosidase inhibition testing among *S. acuta*, *A. indicum* and *M. coromandelianum* extracts were determined *in vitro*. The activity evaluation of alpha-glucosidase from *Saccharomyces cere*visiae was assayed using 1 mM p-nitrophenyl-α-D-glucopyranosiade as substrate. All extracts were analysed in triplicate and 1-deoxynojirimycin was used as the positive control. The α-glucosidase inhibitory effectiveness of different extracts of *S. acuta*, *A. indicum* and *M. coromandelianum* were compared on the basis of their resulting as IC_{50}.

In this study, the alpha-glucosidase inhibition testing of the extracts at concentration of 0.625-10 mg/ml and 0.03-1.5 mg/ml of 1-deoxynojirimycin were demonstrated in Table 17. The results showed that all of the extracts inhibited alpha-glucosidase activity especially the dichloromethane extracts of roots, stems from *A. indicum* and dichloromethane extracts, methanolic extracts of stems from *M. coromandelianum* had a strong effect on alpha-glucosidase inhibition compared to 1-deoxynojirimycin with the IC_{50} of 0.36, 0.45, 0.48 and 0.58 mg/ml respectively.

Table 17 IC_{50} of *S. acuta, A. indicum, M. coromandelianum* extracts on yeast alpha-glucosidase inhibition

Sample	Solvent extract	Plant part	IC_{50} (mg/ml)
Sida acuta .	Dichloromethane fraction	Stems	1.56
		Roots	1.46
		Leaves	1.66
	Methanolic fraction	Stems	5.88
		Roots	8.12
		Leaves	2.38
Abutilon indicum	Dichloromethane fraction	Stems	0.45
		Roots	0.36
		Leaves	1.07
	Methanolic fraction	Stems	1.69
		Roots	1.38
		Leaves	4.21
Malvastrum coromandelianum	Dichloromethane fraction	Stems	0.48
		Roots	0.71
		Leaves	1.07
	Methanolic fraction	Stems	0.48
		Roots	0.74
		Leaves	1.70
1-Deoxynojirimycin			0.58

*The extracts were tested in triplicate.

Rat alpha-glucosidase inhibition activity

The activity of rat intestinal alpha-glucosidase against *S. acuta*, *A. indicum* and *M. coromandelianum* were determined by the method of Yamaki and Mori (2006) with modification using 1 mM p-nitrophenyl-α-D-glucopyranosiade as substrate [70]. The extract solutions were prepared to obtain different concentrations in range of 0.625-10 mg/ml and 0.03-1.5 mg/ml of 1-deoxynojirimycin as positive control. The rat α-glucosidase inhibitory effectiveness of different extracts of *S. acuta*, *A. indicum* and *M. coromandelianum* were compared on the basis of their resulting as IC_{50}. The results were shown in table 18.

From the results, the methanolic extracts of roots from *A. indicum* had a highest effect on rat alpha-glucosidase inhibition compared to 1-deoxynojirimycin with the IC_{50} of 0.08 and 0.11 mg/ml respectively and dichloromethane extracts of stems from *M. coromandelianum* showed weakest effect on this inhibition with the IC_{50} 6.50 mg/ml.

Table 18 IC_{50} of *S. acuta, A. indicum, M. coromandelianum* extracts on rat alpha glucosidase inhibition

Sample	Solvent extract	Plant part	IC_{50}(mg/ml)
Sida acuta .	Dichloromethane fraction	Stems	3.03
		Roots	3.96
		Leaves	2.43
	Methanolic fraction	Stems	2.53
		Roots	1.08
		Leaves	0.19
Abutilon indicum	Dichloromethane fraction	Stems	4.67
		Roots	3.19
		Leaves	2.69
	Methanolic fraction	Stems	1.11
		Roots	0.08
		Leaves	1.38
Malvastrum coromandelianum	Dichloromethane fraction	Stems	6.50
		Roots	0.90
		Leaves	1.55
	Methanolic fraction	Stems	1.35
		Roots	1.88
		Leaves	3.61
1-Deoxynojirimycin			0.11

*The extracts were tested in triplicate.

Alpha-amylase inhibition activity

The alpha-amylase inhibition testing among *S. acuta*, *A. indicum* and *M. coromandelianum* extracts was assayed using 2- chloro-4 nitrophenol-α-D-maltotroside (CNPG-3) as substrate. The activity of α-amylase inhibition was performed as described by Gella *et al* [71] with modification and acarbose was used as the positive control. The alpha-amylase inhibition testing of different extracts of *S. acuta*, *A. indicum* and *M. coromandelianum* at concentration of 0.625-10 mg/ml and 0.03-1.5 mg/ml of positive control were compared on the basis of their resulting as IC_{50}.

The results showed that all of the extracts inhibited alpha-amylase activity especially the dichloromethane extracts of roots from *M. coromandelianum* and methanolic extracts of stems from *M. coromandelianum* had a strongest effect on alpha-amylase inhibition compared to acarbose with the IC_{50} of 0.07 and 2.7 mg/ml respectively. The results were shown in Table 19.

Table 19 IC_{50} of *S. acuta, A. indicum, M. coromandelianum* extracts on alpha-amylase inhibition

Samples	Solvent extract	Plant part	IC_{50}(mg/ml)
Sida acuta .	Dichloromethane fraction	Stems	1.71
		Roots	0.33
		Leaves	1.88
	Methanolic fraction	Stems	2.65
		Roots	0.66
		Leaves	2.08
Abutilon indicum	Dichloromethane fraction	Stems	1.97
		Roots	0.90
		Leaves	1.55
	Methanolic fraction	Stems	1.35
		Roots	1.89
		Leaves	3.61
Malvastrum coromandelianum	Dichloromethane fraction	Stems	2.12
		Roots	0.07
		Leaves	0.81
	Methanolic fraction	Stems	0.07
		Roots	0.28
		Leaves	1.71
Acarbose			2.7

*The extracts were tested in triplicate

Antioxidant activity

The evaluation of antioxidant capacity has been attributed to various mechanisms. Many assays with some modifications have been proposed to evaluate antioxidant activity of an extract or chemical. DPPH radical scavenging, reducing power, nitric oxide and metal chelating assays are the most common assays to evaluate the antioxidant activity. In addition, the assays have been developed to determine scavenging activity by *in vitro* assays.

The antioxidant activities are demonstrated by changing in the absorbance which can be observed by the change of color and measured at a defined wavelength. In this study, the dichloromethane and methanolic extracts from different plant parts of *S. acuta* were described for the abilities to inhibit various oxidation mechanisms *in vitro*. The results of DPPH radical scavenging and nitric oxide scavenging properties as well as metal chelating and reducing power activities of different extracts of *S. acuta* were shown in Table 20-21 and Figure 6.

DPPH scavenging activity

DPPH$^{\cdot}$ is a stable free radical with deep violet color. In the presence of a free radical scavenger, DPPH$^{\cdot}$ is neutralized to DPPH$^{\cdot}$R and becomes pale yellow color.

The free radical scavenging activity of *S. acuta* extracts were tested for their inhibition of DPPH bleaching by measuring DPPH absorbamce at 517 nm. The scavenging activities of the extracts and ascorbic acids as positive control at the concentrations of 0.00195-1 mg/ml and 0.001-0.03 mg/ml respectively were determined and the concentration that scavenged 50% DPPH radical (IC_{50}) were evaluated as shown in Table 20. The greatest scavenger of DPPH radical was showed by dichloromethane extracts of roots (IC_{50}=0.20 mg/ml).

Nitric oxide scavenging activity

Nitric oxide is derived from L-arginine through the enzyme nitric oxide synthase (NOS) and NO donors, such as sodium nitroprusside (SNP). It is a free radical gaseous molecule which is one of the simplest compounds found to be continuously produced in humans and animals. *In vitro*, sodium nitroprusside (SNP) decomposes in an aqueous solution at physiological pH to produce NO. The NO reacts with oxygen under aerobic condition and producing stable nitrite product which can be quantify from the reaction with Griess reagent. Antioxidants were reported to be able to prevent NO radical chemaically derived by SNP.

In the studying, nitric oxide scavenging activity from *S. acuta* extracts at concentration of 0.02-5 mg/ml and quercetin at the concentration of 0.001-0.5 mg/ml were demonstrated in Table 20. The highest NO scavenging activity was shown from the dichloromethane extract of leaves (IC_{50}=0.11 mg/ml).

Metal chelating activity

Metal chelating capacity of antioxidant is significant in reducing the concentration of transition metal participated in lipid peroxidation and inhibiting the function of membrane protein. The transition metals have a major role in the generation of reactive oxygen species free radicals in the living organism. Iron exists as ferrous (Fe^{2+}) and ferric (Fe^{3+}). Fe^{2+}/ Fe^{3+} electron transition catalyses H_2O_2 inducing hydroxyl radicals *via* Fenton reaction.

In studying the metal chelating effect of a substance, ferrozine -Fe^{2+} complex formation was measured. The metal chelation was carried out at the various concentrations of the extracts (0.001-5 mg/ml) and EDTA (0.07-0.21 mg/ml) which used as positive control. From the results, the dichloromethane extract of leaves and methanolic extract of roots showed metal chelating potential more than other extracts with IC_{50} of 1.6 mg/ml. The results were demonstrated in Table 20.

Table 20 IC_{50} of DPPH scavenging activity, Nitric Oxide scavenging activity and Metal Chelating activity of different extractives of *S. acuta*

Solvent extract	Plant part	DPPH radical scavenging (mg/ml)	Nitric Oxide scavenging property (mg/ml)	Metal chelating activity (mg/ml)
Dichloromethane fraction	Stems	0.31	0.92	2.27
	Roots	0.20	0.84	2.72
	Leaves	1.83	0.11	1.57
Methanolic fraction	Stems	0.41	1.12	2.19
	Roots	0.62	0.92	1.63
	Leaves	0.30	0.21	2.05
Ascorbic acid		0.01	ND	ND
EDTA		ND	ND	0.13
Quercetin		ND	0.03	ND

*The extracts were tested in triplicate

Reducing power capacity

Reducing capacity of a compound is served as a significant indicator of potential antioxidant activity. It is important that the compound can maintain its stability, after reduction of an oxidant that not turns into free radical itself on the assessing antioxidant. The antioxidant power is known for its reducing ability in conversion of Fe^{3+} (ferricyanide) to Fe^{2+} (ferrocyanide) which reacts with ferric chloride to form ferric ferrocyanide complex. In this assay, the yellow color of tested solution changed to various shades of green to blue which depended on the reducing power of the extracts. The absorbance of the complex was measured at 700 nm. The higher absorbance indicated the higher reducing power.

The reducing power assay was carried out at the extract concentration 1 mg/ml. Quercetin and BHT (1 mg/ml) were used as positive control. The reducing capacity was evaluated from the calibration curve of ferric chloride complex according to figure 5. The highest reducing capacity was exhibited by the extracts of leaves from dichloromethane fraction as shown on Table 21.

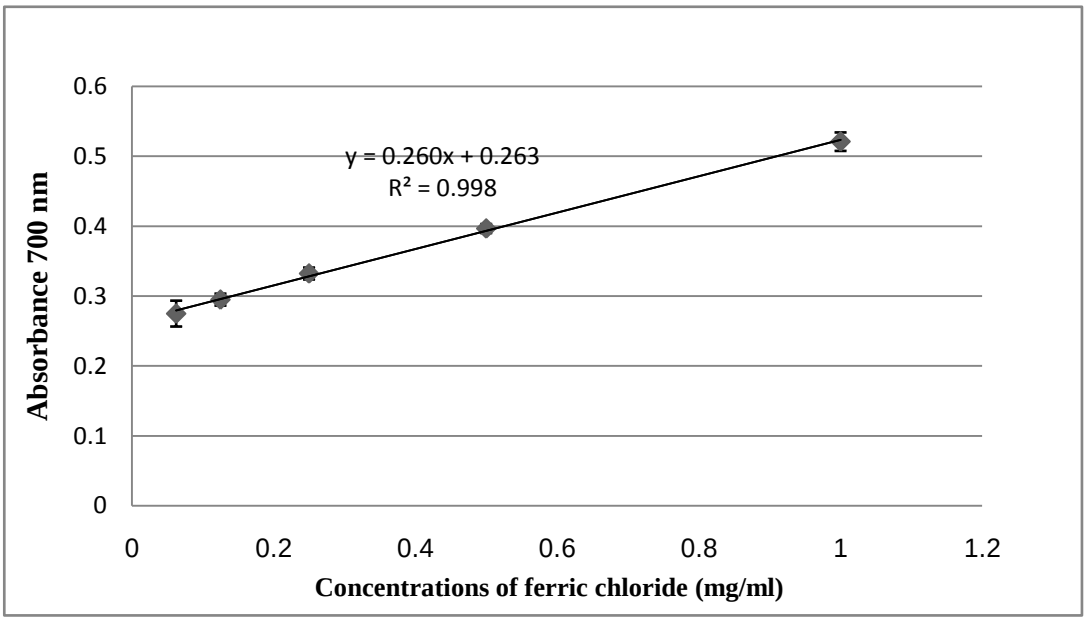

Figure 5 Calibration curve of ferric chloride complex

Table 21 Reducing power capacity of different extracts of *S. acuta* at 1 mg/ml

S. acuta extract	Plant part	Reducing power capacity (mg/ml)
Dichloromethane fraction	Stems	0.06±0.01
	Roots	0.22±0.10
	Leaves	2.45±0.02
Methanolic fraction	Stems	0.04±0.04
	Roots	0.04±0.03
	Leaves	1.50±0.12
BHT		4.80±0.07
Quercetin		3.09±0.48

*****Data±SD and the extracts were tested in triplicate

Brine shrimp lethality assay

The brine shrimp lethality test is one of the elementary assays that used to warrant the medicinal plants extract. The different extracts of *S. acuta* were evaluating their cytotoxic activity on *Artemia salina.* The extracts at the concentrations ranging 1000 - 9000 µg/ml were exposed to the 48 hours old of *A. salina* for 24 hours. Toxic strength of the extracts tested was classified by LC_{50} as toxic with the LC_{50} value <1000 µg/ml and non toxic if LC_{50} value =1000 µg/ml [73].

The dichloromethane and methanol extracts of different plant parts evaluated for their cytotoxicity activity were shown in Table 22. The results demonstrated that the different extracts of *S. acuta* of all tested concentrations caused no lethality to brine shrimp regarding to be as non toxic with LC_{50} value >9000 µg/ml.

Table 22 Cytotoxicity activity of brine shrimp lethality as LC_{50} on different extractives of *S. acuta*

Solvent extract	Plant part	LC_{50} (µg/ml)
Dichloromethane fraction	Stems	>9000
	Roots	>9000
	Leaves	>9000
Methanolic fraction	Stems	>9000
	Roots	>9000
	Leaves	>9000

CHAPTER V

DISCUSSION AND CONCLUSION

The practices of traditional medicine have been developing along with the cultures of ancient Thailand and other places. In the last decade, herbal medicines are becoming very popular and developmental in many countries around the world. The herbal medicines are also used as a remedies and raw materials for the pharmaceutical industry. Plants are one of the important sources for the development of new therapeutic drugs. Many phytochemical or bioactive compounds are derived from plant. The use of plants for prevention and treatment of diseases are the earliest type of medicine on earth.

The purposes of this present study were to investigate the bioactive properties of selected Malavceous plant materials. Additionally, the alkaloids in *S. acuta* are qualitatively characterized. This study provides scientific information to continually validate the potential of the plants known as ethnomedicine in Thailand.

The ability of the plant extract to kill or inhibit the growth of microorganisms and parasite are interesting to the development of antimicrobial and antimalarial agent. The dichloromethane and methanol extracts of stems, roots, leaves from *S. acuta* were investigated for antimicrobial activities. The results demonstrated that the dichloromethane extract of stems exhibited great antimicrobial activity on *Saccharomyces cerevisiae* with the inhibition zone of 32.7±0.6 mm and the methanolic extract of leaves exhibited great antimicrobial activity on *Shigella sp.* at 30.3±0.6 mm (Figure 6-8 and Table 3-15). Moreover, the methanolic extract of leaves and dichloromethane extract of stems showed the lowest MIC on *Saccharomyces cerevisiae* while the methanolic extract of leaves showed the lowest MBC on *Straphyloccoccus aureus* (125 and 250µg/ml respectively).

The positive controls, ampicillin and amikacin showed antimicrobial against *Staphylococcus aureus* (50.7±1.2 mm) and *Shigella sp*. (28.0±0.0 mm) but didn't affect on both *Candida albicans* and *Saccharomyces cerevisiae*. DMSO didn't affect all tested organisms. The results from various parts of plant exhibited different

antimicrobial potential against all tested microorganism. The antimicrobial effect was selective depended on the microorganism species as well as parts of the plants.

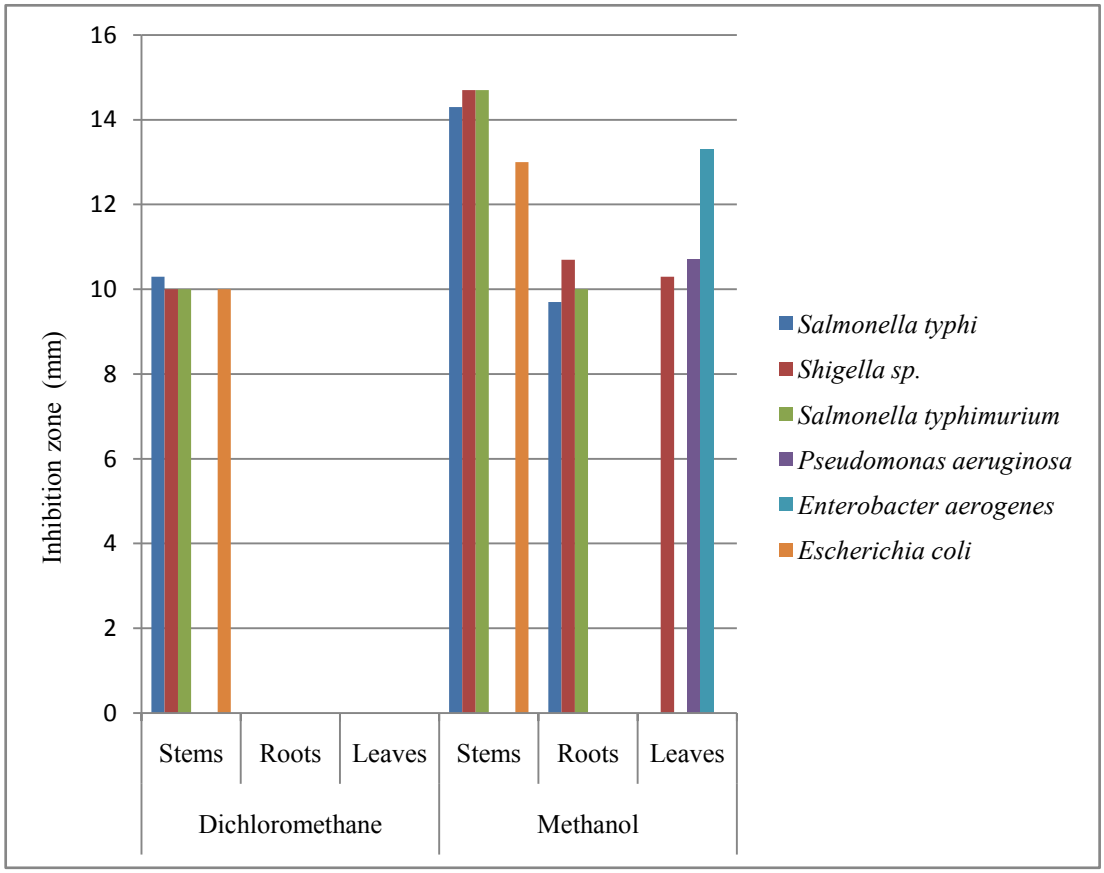

Figure 6 Spectrum of antimicrobial activity among *S. acuta* extracts against gram negative bacteria

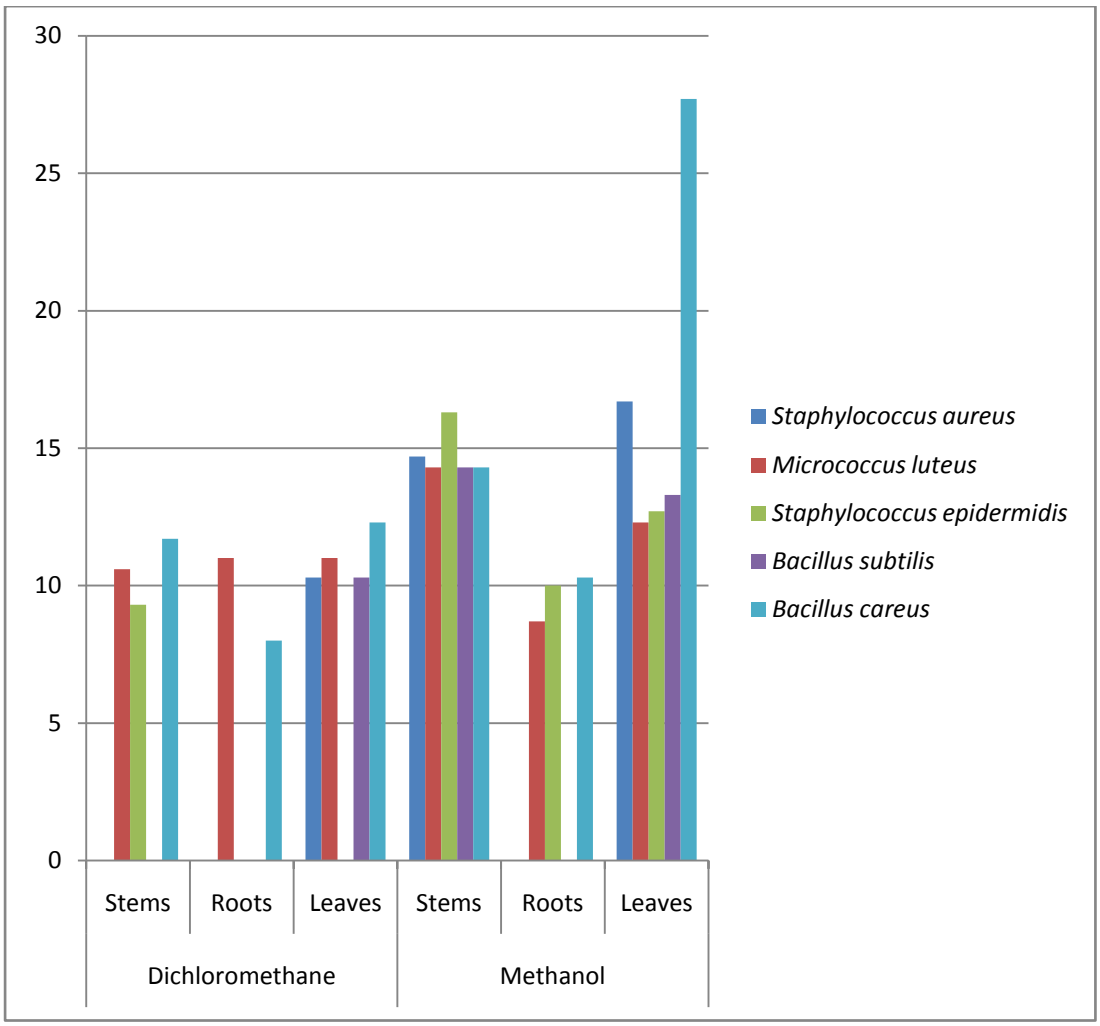

Figure 7 Spectrum of antimicrobial activity among *S. acuta* against gram positive bacteria

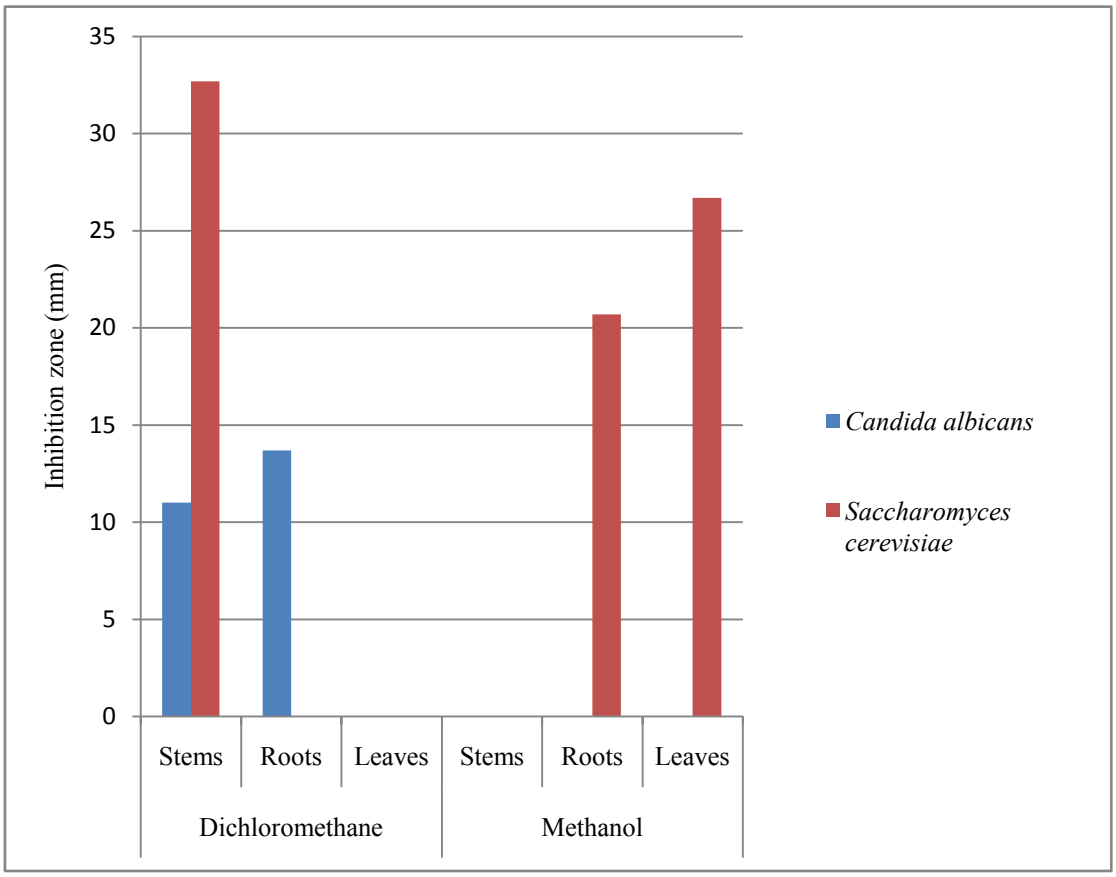

Figure 8 Spectrum of antimicrobial activity among *S. acuta* against fungi

The results of antimalarial activities of *S. acuta* extracts against K1 chloroquine-resistant *P. falciparum* and 3D7 chloroquine-sensitive *P. falciparum* clones are presented in Table 16. The methanolic extract of leaves showed promising antimalarial activity on both clones (IC_{50} < 5 µg/ml) whilst methanolic extract of stems as well as dichloromethane extract of roots and demonstrated moderate activity (5 µg/ml < IC_{50} < 50 µg/ml). One hundred micromolars of dihydroartemisinin (DHA) as positive control showed 100% inhibition. The previous study also reported that aqueous fraction of *S. acuta* whole plants had high antimalarial activity and this effect was from its alkaloidal substances [74]. This study isolated crude alkaloid from *S. acuta* whole plants and revealed IC_{50} of 6 and 9 µg/ml for both strains respectively. This could be confirmed the antimalarial potential of *S. acuta* especially the methanolic extract of leaves.

In antidiabetes mellitus, the control of postprandial plasma glucose level is critical in the early treatment. Inhibition of enzymes involved in the metabolism of carbohydrates is one of the therapeutic approaches for reducing postprandial hyperglycemia. Diabetes mellitus is a deadful disorder and leads to various other metabolic disorder. It is estimated that its annual incidence rate will continue to increase in the future worldwide.

The antidiabetic properties of plants can be evaluated by various methods such as alpha-amylase assayed using 2- chloro-4 nitrophenol-α-D-maltotroside (CNPG-3) as substrate, alpha-glucosidase from *Saccharomyces cere*visiae and rat intestinal alpha-glucosidase assayed using 1 mM p-nitrophenyl-α-D-glucopyranosiade as substrate.

Alpha-amylase is an enzyme found in the salivary and prancreatic secretions, functioning in the breakdown of the α-1-4-glycosidic bonds in starch. This enzyme increases the bioavailability of glucose in the blood.

Alpha – glucosidase is a key enzyme in carbohydrate digestion at intestinal mucosa. It catalyzes the hydrolysis of α-1,4-glucosidic and α-1,6-glucosidic bonds of dixtrins from amylase – digested starch and promotes the increase of blood glucose level. The α-glucosidase inhibitor such as acarbose and voglibose are clinically used

as oral antihyperglycemic agents [53,54]. However, they still often cause severe gastrointestinal side effect. Therefore, search for new α-glucosidase inhibitors from natural resources has become an attractive approach for the treatment of postprandial hyperglycemia.

In this *in vitro* study, *S. acuta, A. indicum, M. coromandelianum* extracts demonstrates an appreciable inhibitory activity on α-amylase, α -glucosidase from *Saccharomyces cere*visiae and rat intestinal alpha-glucosidase inhibitory compared to 1-deoxynojirimycin and acarbose. The previous study also reported that *Abutilon indicum* (L.) Sweet and *Malvastrum coromandelianum* (Linn.) Garcke were another Malvaceous plants with hypoglycemic potential in animal model [5-9].

The effect of antioxidants on DPPH is due to their hydrogen donating ability. Free radicals are known to be a major factor in biological damages and DPPH has been used to evaluate the free radical scavenging activity of natural antioxidants. The reduction of DPPH radical is determined by the decrease in its absorbance at 517 nm, induced by antioxidants. In order to evaluate the antioxidant potency through free radical by the test sample, the change of optical density of DPPH radicals was monitored. Table 20 shows IC_{50} of DPPH radical scavenging on different extracts of *S. acuta.* In this assay the greatest scavenging of DPPH radical was shown by dichloromethane extract of roots (IC_{50}=0.20mg/ml) comparable with positive control ascorbic acid.

It is well known that nitric oxide plays an important role in various inflammatory processes. Sustained levels of production of this radical are directly toxic to tissues and contribute to the vascular collapse associated with septic shock, whereas chronic expression of nitric oxide radical is associate with various carcinoma and inflammatory conditions including juvenile diabetes, multiple sclerosis, arthritis and ulcerative colitis [75]. The NO increases greatly when it is react with superoxide radical forming the highly reactive peroxynitrite anion ($ONOO^-$). The nitric oxide generated from sodium nitroprusside reacts with oxygen to form nitrite. The Nitric oxide scavenging activity from *S. acuta* extracts at concentration of 0.02-5.00 mg/ml and 0.03-0.50 mg/ml of quercetin were demonstrated in Table 20. Quercetin is shown

pronounced NO scavenging activity due to its chemical structures which possessed free OH group and absence of glycoside group [76]. The highest NO scavenging activity was shown by the extract of leaves from dichloromethane (IC_{50}=0.11 mg/ml). Thus, the extracts may have the property to counteract the effect of NO formation and in turn of considerable interest in preventing the ill effect of excessive NO generation in the human body.

In studying the metal chelating effect of a substance, ferrozine has been used to form meganta with ferrous iron (Fe^{2+}). The presence of chelating agent will disrupt the formation of Fe^{2+} Ferrozine complex and eventually fading the magenta color of complex. Metal chelating capacity of antioxidant was significant in reducing the concentration of transition metal participated in lipid peroxidation and inhibiting the function of membrane protein. Iron exists as ferrous (Fe^{2+}) and ferric (Fe^{2+}). The transition metals have a major role in the generation of oxygen free radical in the living organism. According to the results, the dichloromethane and methanolic extracts of roots and leaves shown great scavenging on metal chelating with IC_{50} 1.57 mg/ml compared to 0.11mg/ml of EDTA as positive control.

The reducing properties are generally associated with the presence of reductions, which have been shown to exert antioxidant action by breaking the free radical chain by donating a hydrogen atom. The presence antioxidant known for its reducing ability causes the conversion of the ferricyanide to ferrocyanide which further reacts with ferric chloride to form ferric-ferrocyanide complex. In this assay, the yellow color of the test solution changes to various shades of green and blue which depends on the reducing potential of extracts and measuring the formation of the color at 700 nm. The highest reducing capacity was exhibited by the extracts of leaves from dichloromethane fraction as shown on Figure 5. The reducing ability of this extract was comparable to quercetin and BHT (2.45, 3.09 and 4.80 mg/ml respectively).

In many studies regarding the antioxidant activity of extract, DPPH radical scavenging, reducing power, nitric oxide and metal chelating assays are the most common assays to evaluate the antioxidant activity. In this study, the

dichloromethane and methanolic extracts from different plant parts of *S. acuta* were described for the scavenging abilities. The results were selective depended on the oxidative species as well as parts of the plants.

The brine shrimp lethality test is the elementary assays that used to warrant the medicinal plants extract. The different extracts of *S. acuta* were evaluated for their cytotoxic activity on *Artemia salina.* The results demonstrated that the dichloromethane and methanol extracts of different plant parts expressed LC_{50} value >1000 μg/ml as shown in Table 22. According to brine shrimp lethality criterion described by Meyer *et al*. that the extract with LD_{50} greater than 1000 μg/ml was no toxic [74].

This present study revealed the bioactive potential of selected Malavaceous plant materials. In addition, the *in vitro* studies of *S. acuta, A. indicum, M. coromandelianum* extracts demonstrate an appreciable inhibitory activity on α-amylase and α -glucosidase both from *Saccharomyces cere*visiae and rat intestinal. The results could expand our knowledge in Thai traditional plant usage. Moreover, this study contribute the use of *S. acuta* in Thai folk medicine and providing sciencetific information to continually validate the potential of the plants known as ethnomedicine in Thailand.

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APPENDICES

APPENDIX A

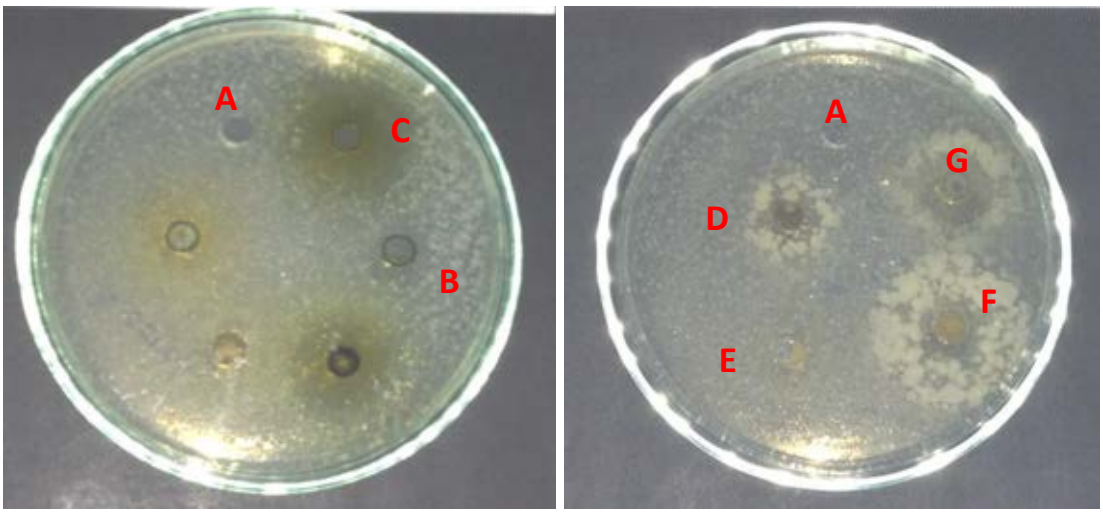


Figure 9 The inhibition zone of *Bacillus cereus* from *Sida acuta* Burm. f.: **A.** DMSO **B.** dichloromethane extract of leaves, **C.** methanolic extract of leaves, **D.**dichloromethane extract of roots, E. methanolic extract of roots, F. dichloromethane extract of stem, G. methanolic extract of stems

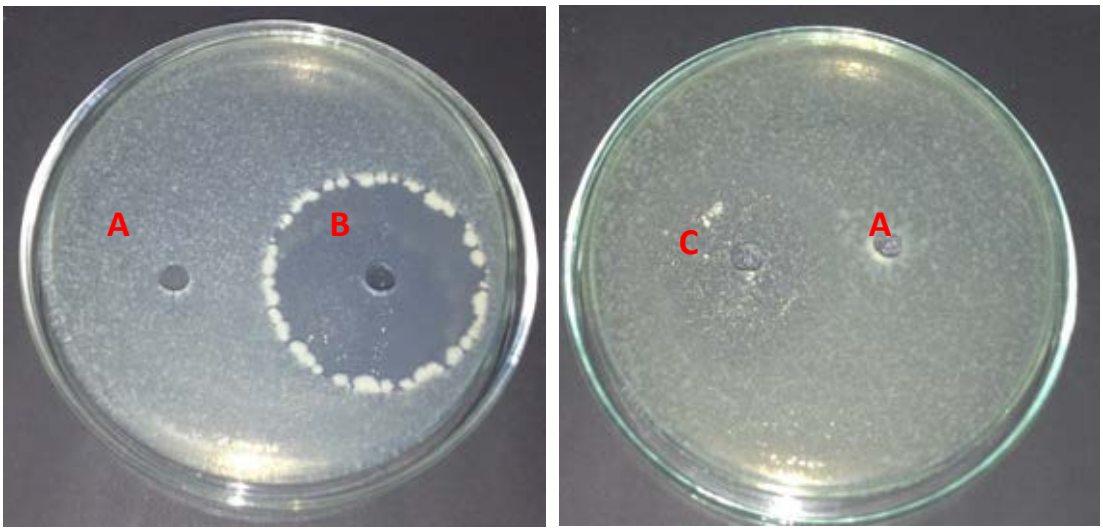


Figure 9 The inhibition zone of *Bacillus cereus* (cont.) from **A.** DMSO **B.** Ampicillin sodium, **C.** Amikacin sulfate

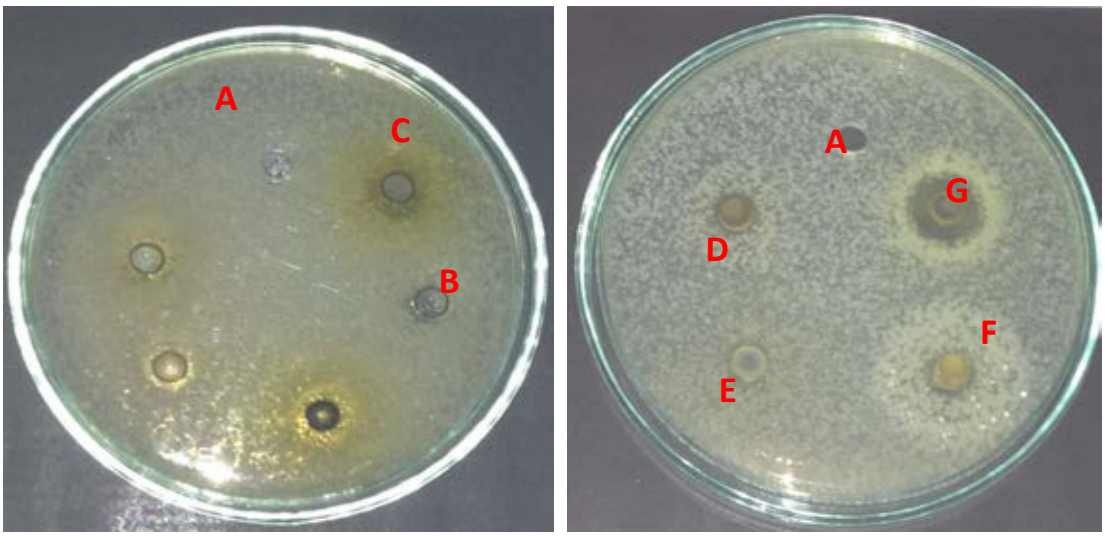


Figure 10 The inhibition zone of *Bacillus subtilis* from *Sida acuta* Burm. f.: **A.** DMSO **B.** dichloromethane extract of leaves, **C.** methanolic extract of leaves, **D.**dichloromethane extract of roots, E. methanolic extract of roots, F. dichloromethane extract of stem, G. methanolic extract of stems

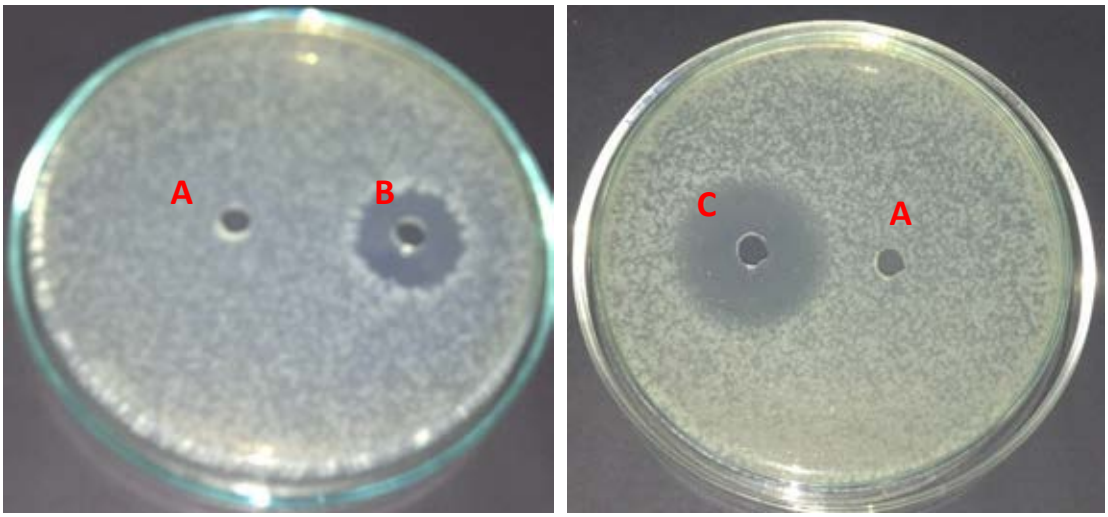


Figure 10 The inhibition zone of *Bacillus subtilis* (cont.) from **A.** DMSO **B.** Ampicillin sodium, **C.** Amikacin sulfate

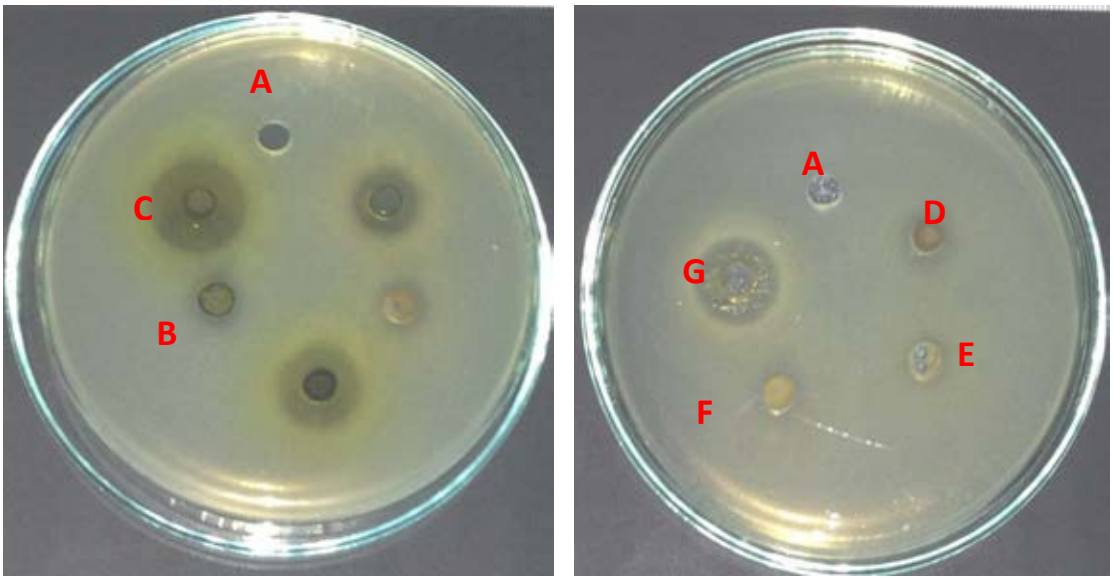


Figure 11 The inhibition zone of *Staphylococcus aureus* from *Sida acuta* Burm. f.: **A.** DMSO **B.** dichloromethane extract of leaves, **C.** methanolic extract of leaves, **D.**dichloromethane extract of roots, E. methanolic extract of roots, F. dichloromethane extract of stem, G. methanolic extract of stems

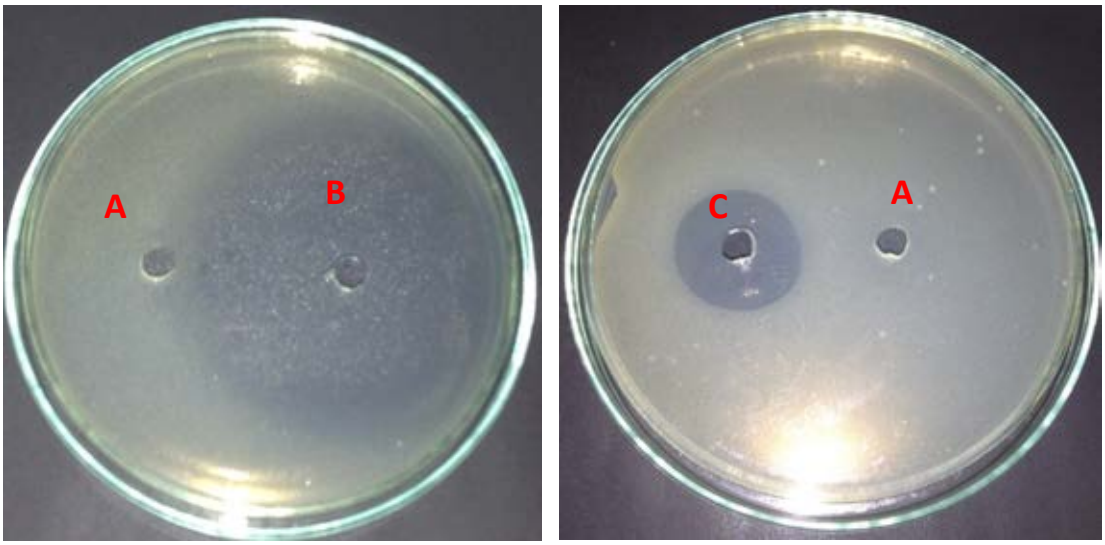


Figure 11 The inhibition zone of *Straphyloccus aureus* (cont.) from **A.** DMSO **B.** Ampicillin sodium, **C.** Amikacin sulfate

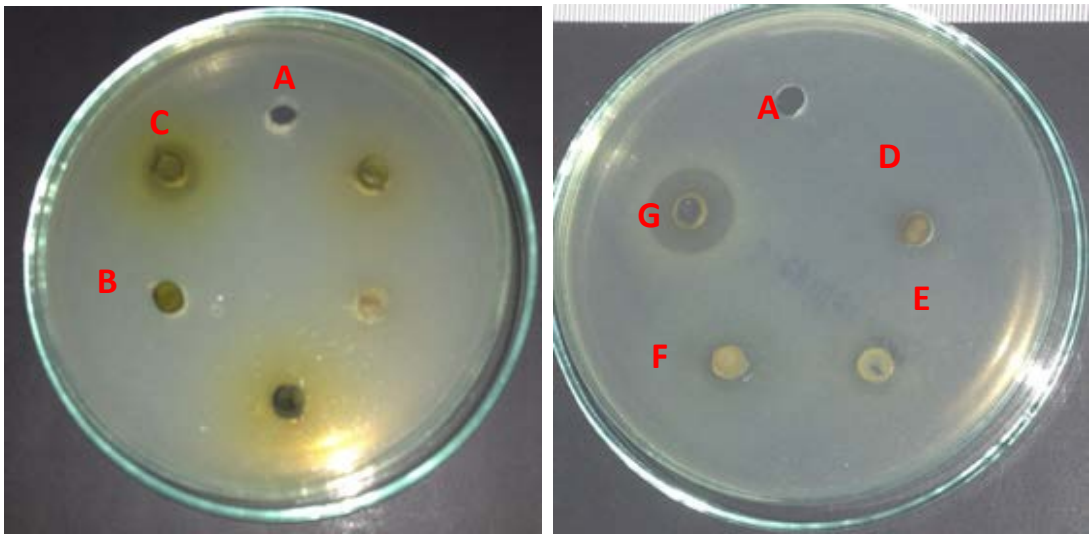


Figure 12 The inhibition zone of *Staphylococcus epidermidis* from *Sida acuta* Burm.f.: **A.** DMSO **B.** dichloromethane extract of leaves, **C.** methanolic extract of leaves, **D.**dichloromethane extract of roots, E. methanolic extract of roots, F. dichloromethane extract of stem, G. methanolic extract of stems

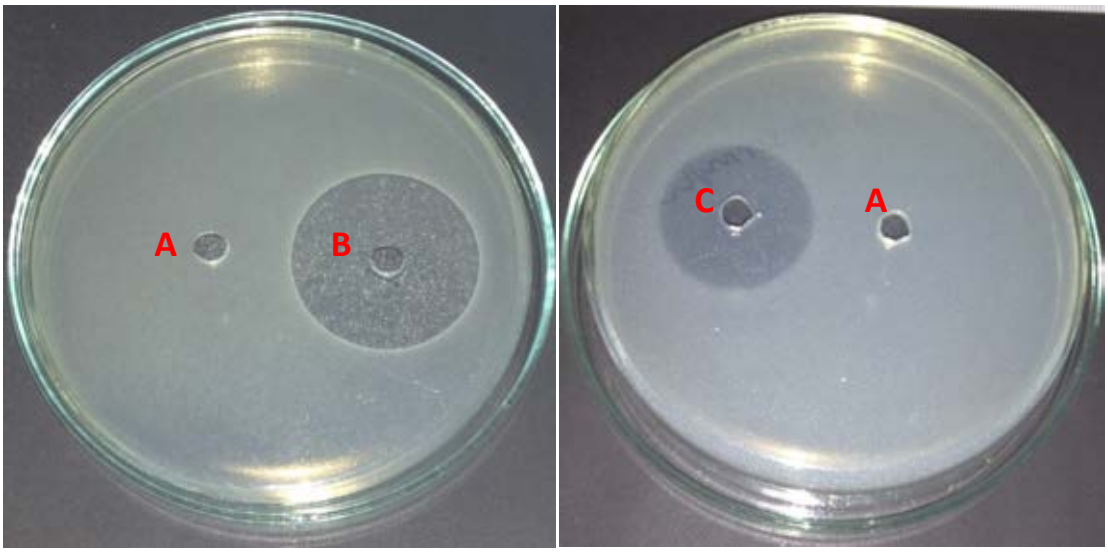


Figure 12 The inhibition zone of *Straphylococcus epidermidis* (cont.) from **A.** DMSO **B.** Ampicillin sodium, **C.** Amikacin sulfate

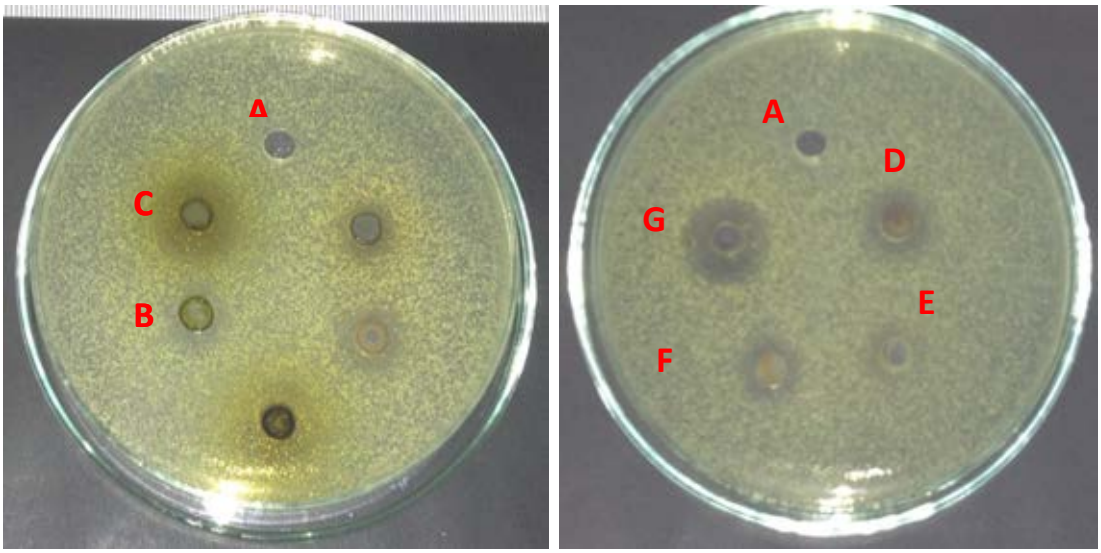


Figure 13 The inhibition zone of *Micrococcus luteus* from *Sida acuta* Burm. f.: **A.** DMSO **B.** dichloromethane extract of leaves, **C.** methanolic extract of leaves, **D.**dichloromethane extract of roots, E. methanolic extract of roots, F. dichloromethane extract of stem, G. methanolic extract of stems

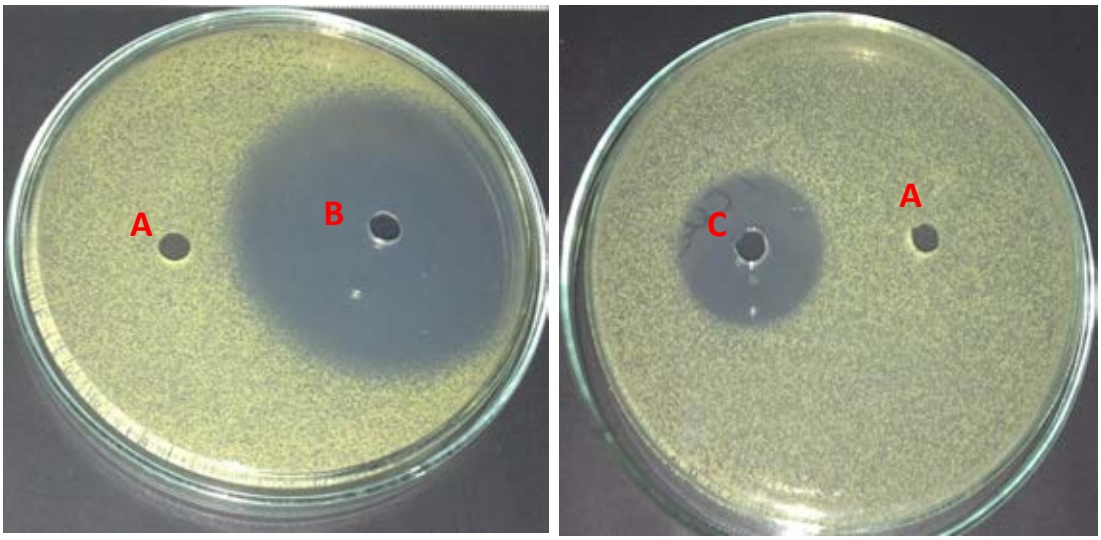


Figure 13 The inhibition zone of *Micrococcus luteus* from (cont.) **A.** DMSO **B.** Ampicillin sodium, **C.** Amikacin sulfate

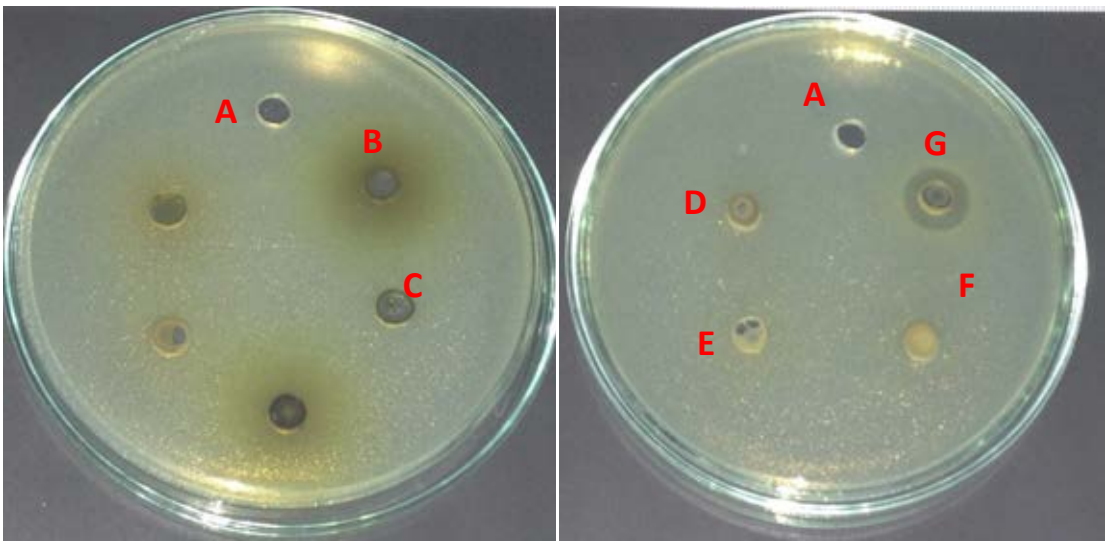


Figure 14 The inhibition zone of *Escherichia coli* from *Sida acuta* Burm. f.: **A.** DMSO **B.** dichloromethane extract of leaves, **C.** methanolic extract of leaves, **D.**dichloromethane extract of roots, E. methanolic extract of roots, F. dichloromethane extract of stem, G. methanolic extract of stems

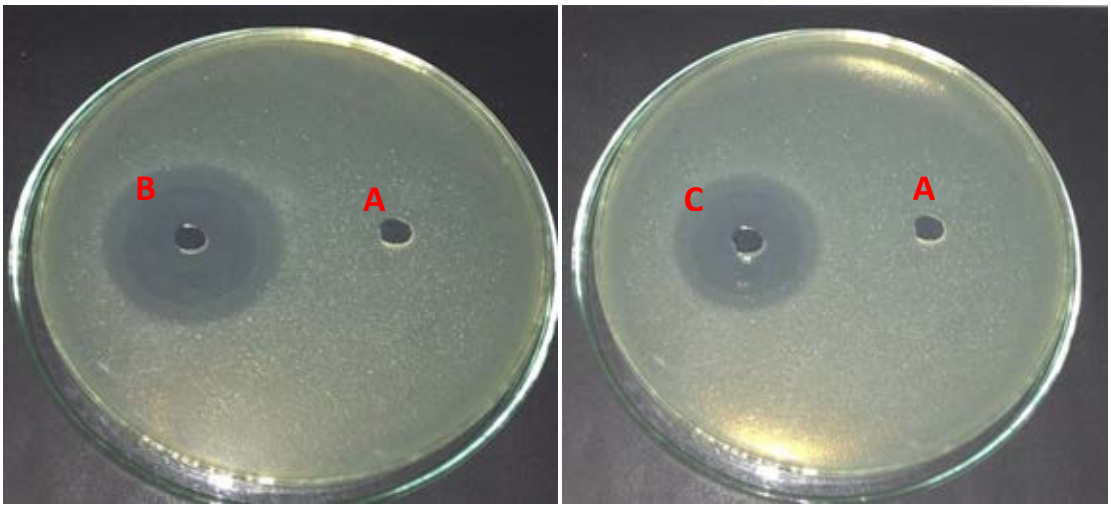


Figure 14 The inhibition zone of *Escherichia coli* (cont.) from **A.** DMSO **B.** Ampicillin sodium, **C.** Amikacin sulfate

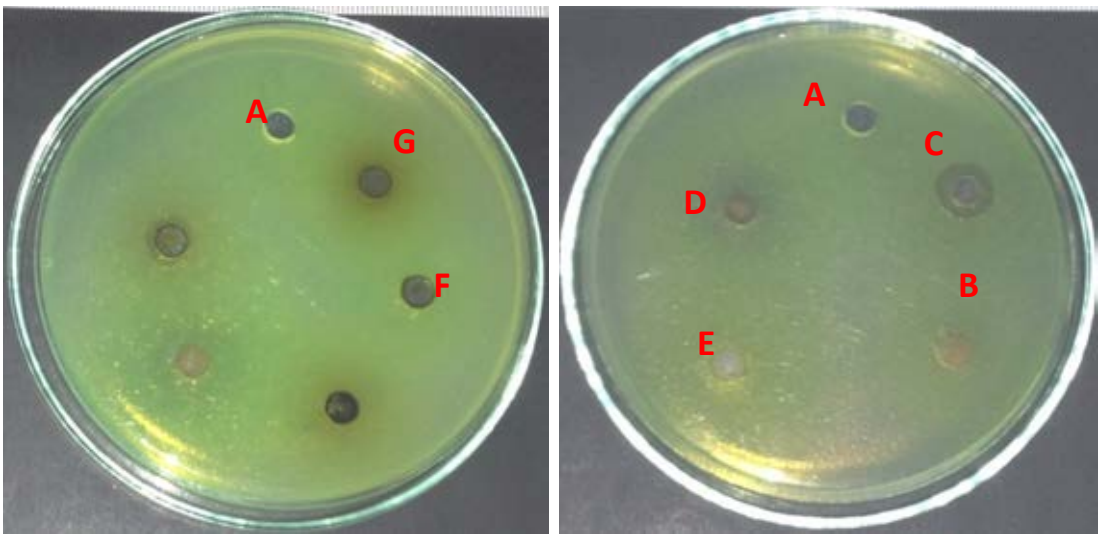


Figure 15 The inhibition zone of *Pseudomonas aeruginosa* from *Sida acuta* Burm. f.: **A.** DMSO **B.** dichloromethane extract of leaves, **C.** methanolic extract of leaves, **D.**dichloromethane extract of roots, E. methanolic extract of roots, F. dichloromethane extract of stem, G. methanolic extract of stems

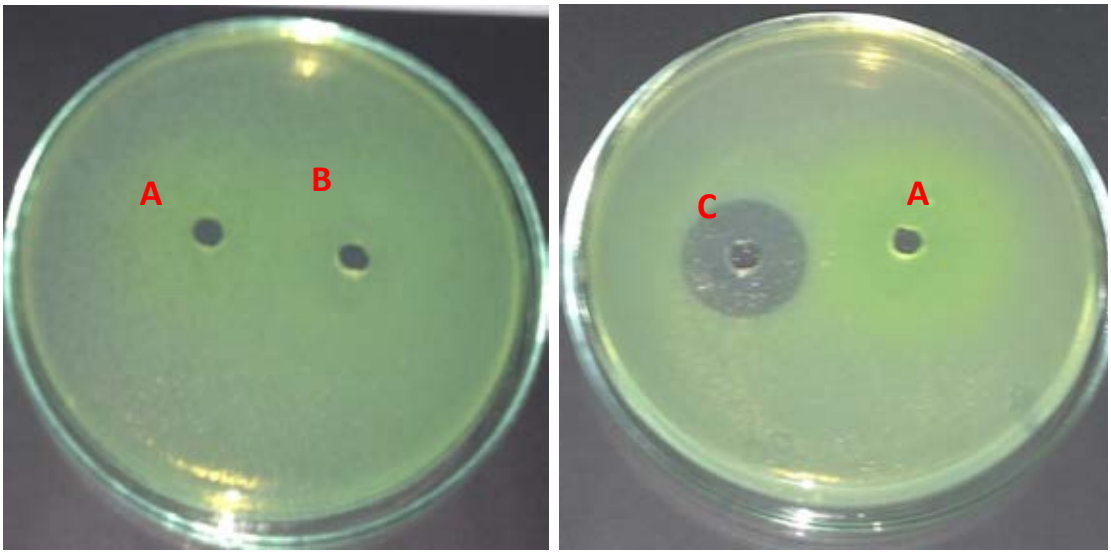


Figure 15 The inhibition zone of *Pseudomonas aeruginosa* (cont.) from **A.** DMSO **B.** Ampicillin sodium, **C.** Amikacin sulfate

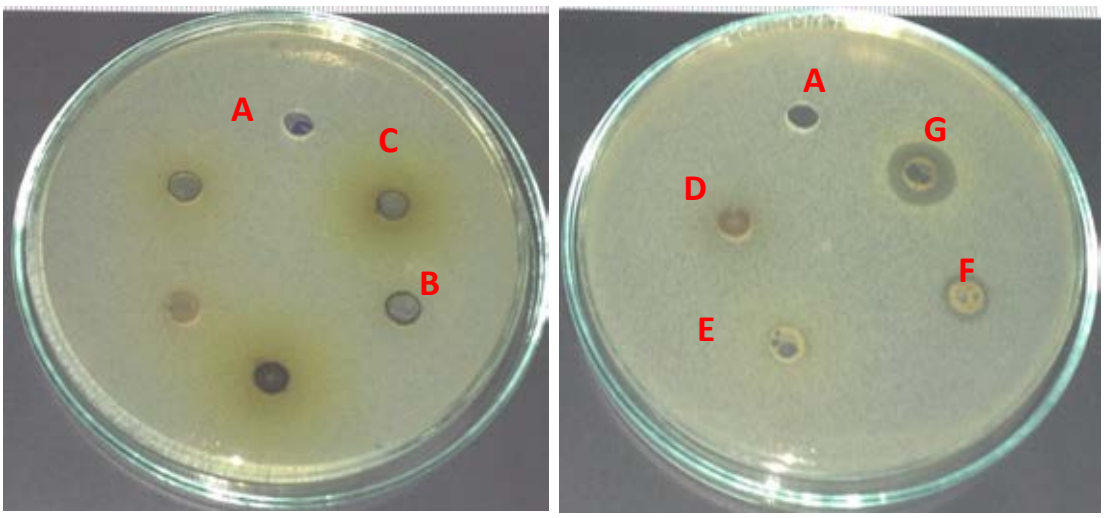


Figure 16 The inhibition zone of *Enterobacter aerogenes* from *Sida acuta* Burm. f.: **A.** DMSO **B.** dichloromethane extract of leaves, **C.** methanolic extract of leaves, **D.**dichloromethane extract of roots, E. methanolic extract of roots, F. dichloromethane extract of stem, G. methanolic extract of stems

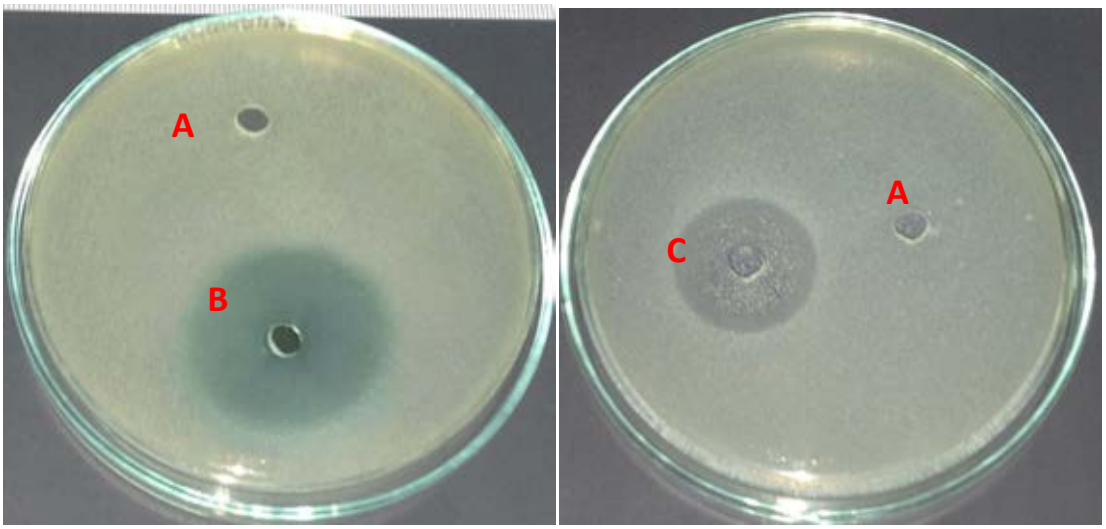


Figure 16 The inhibition zone of *Enterobacter aerogenes* (cont.) from **A.** DMSO **B.** Ampicillin sodium, **C.** Amikacin sulfate

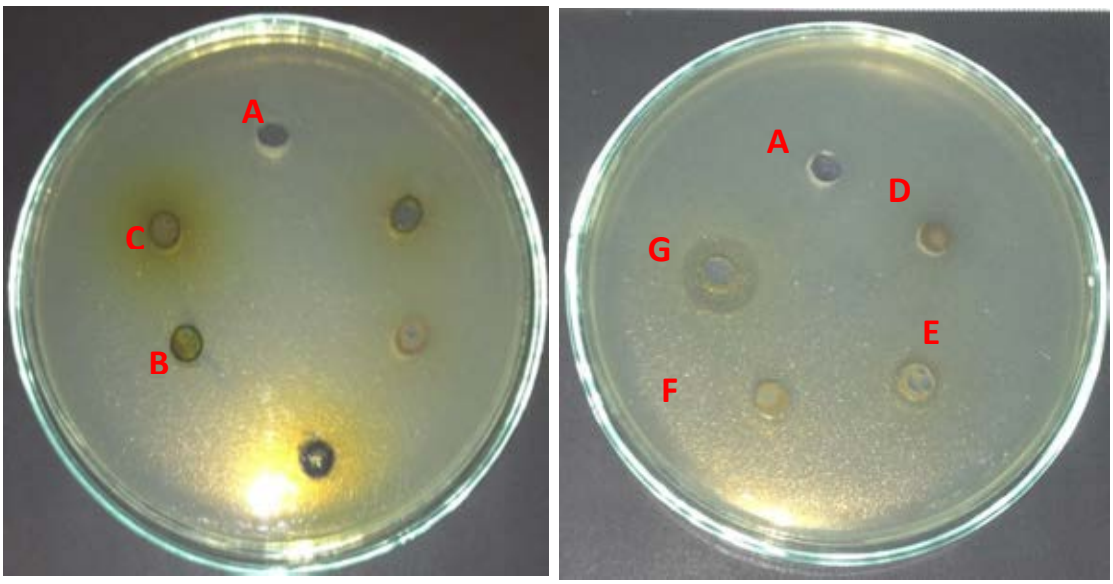


Figure 17 The inhibition zone of *Salmonella typhi* from *Sida acuta* Burm. f.: **A.** DMSO **B.** dichloromethane extract of leaves, **C.** methanolic extract of leaves, **D.**dichloromethane extract of roots, E. methanolic extract of roots, F. dichloromethane extract of stem, G. methanolic extract of stems

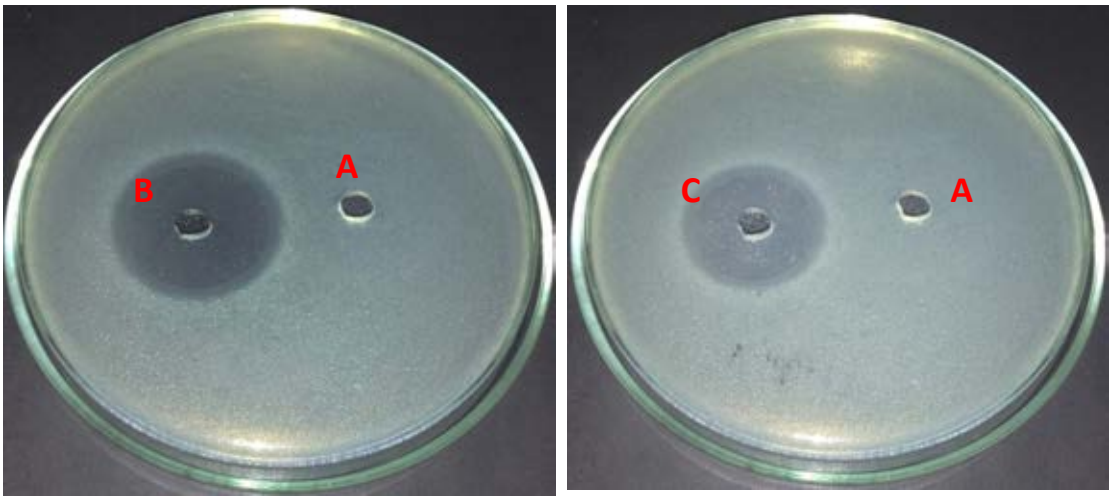


Figure 17 The inhibition zone of *Salmonella typhi* (cont.) from **A.** DMSO **B.** Ampicillin sodium, **C.** Amikacin sulfate

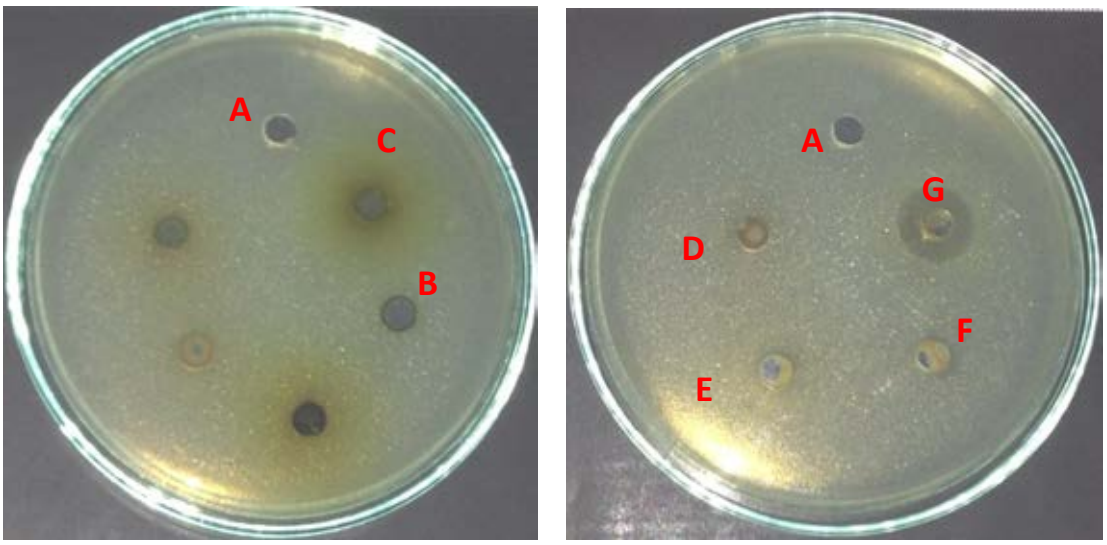


Figure 18 The inhibition zone of *Salmonella typhimurium* from *Sida acuta* Burm. f.: **A.** DMSO **B.** dichloromethane extract of leaves, **C.** methanolic extract of leaves, **D.** dichloromethane extract of roots, E. methanolic extract of roots, F. dichloromethane extract of stem, G. methanolic extract of stems

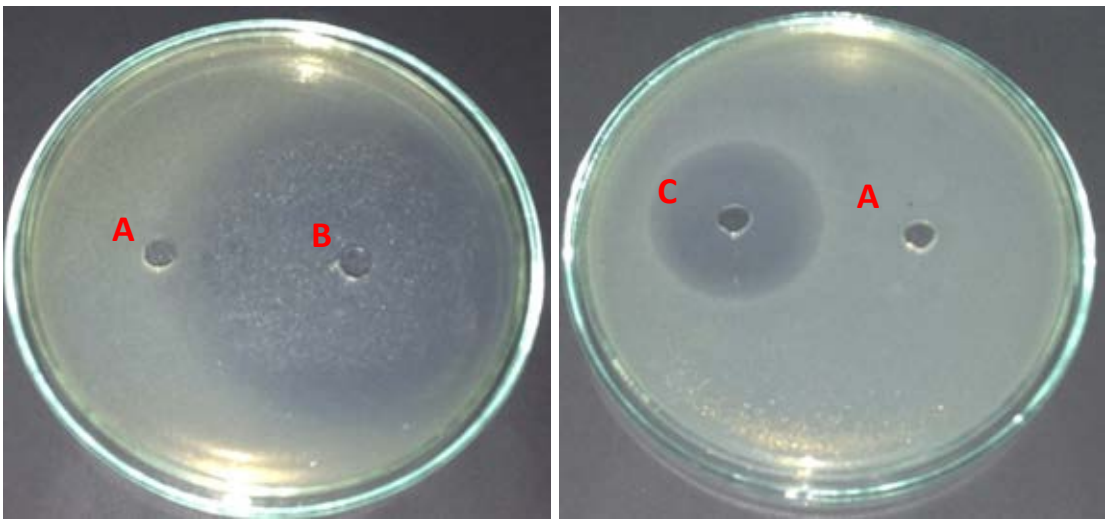


Figure 18 The inhibition zone of *Salmonella typhimurium* (cont.) from **A.** DMSO **B.** Ampicillin sodium, **C.** Amikacin sulfate

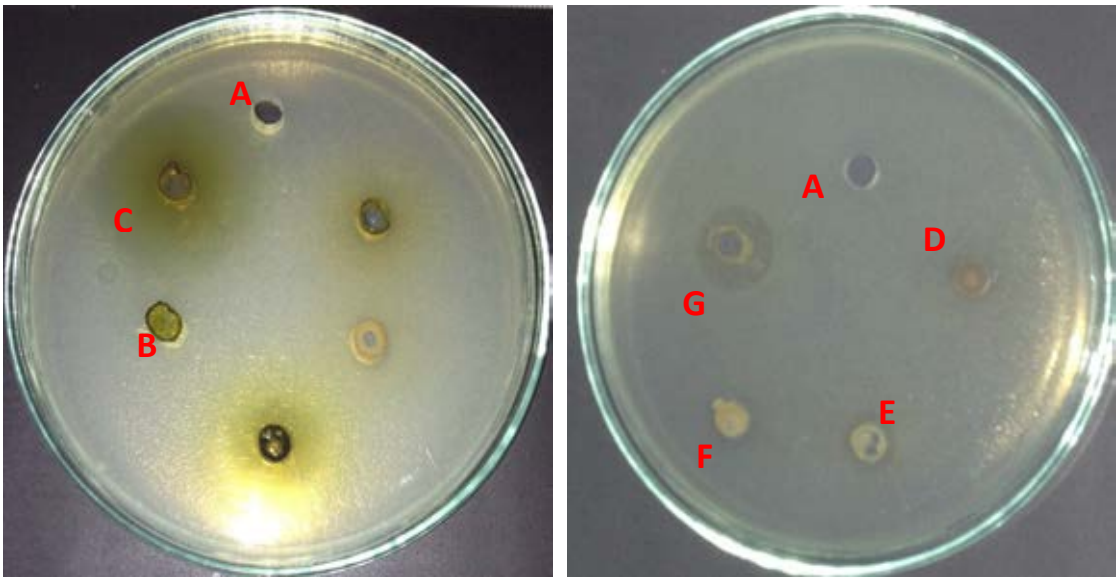


Figure 19 The inhibition zone of *Shigella sp.* from *Sida acuta* Burm. f.: **A.** DMSO **B.** dichloromethane extract of leaves, **C.** methanolic extract of leaves, **D.** dichloromethane extract of roots, E. methanolic extract of roots, F. dichloromethane extract of stem, G. methanolic extract of stems

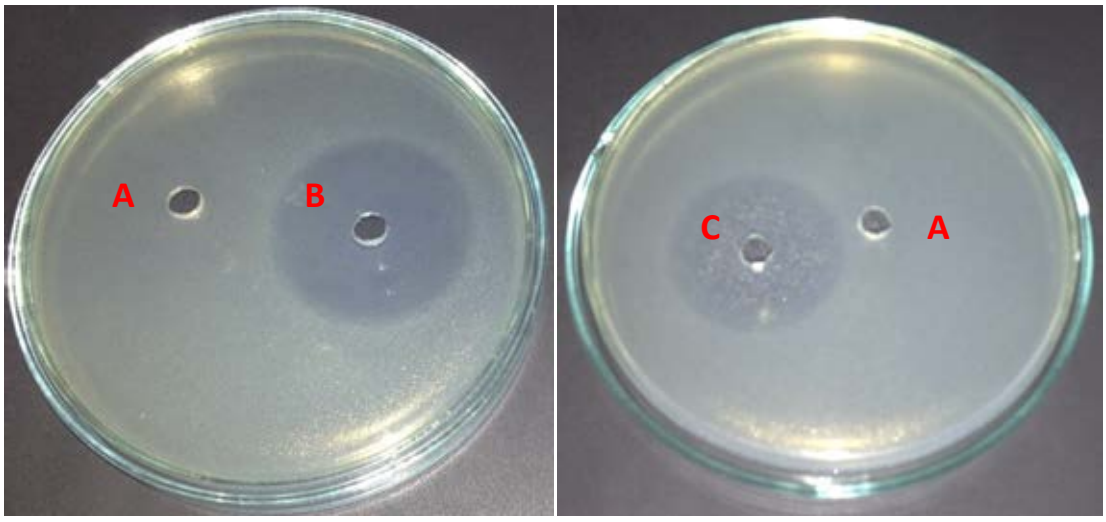


Figure 19 The inhibition zone of *Shigella sp.* (cont.) from **A.** DMSO **B.** Ampicillin sodium, **C.** Amikacin sulfate

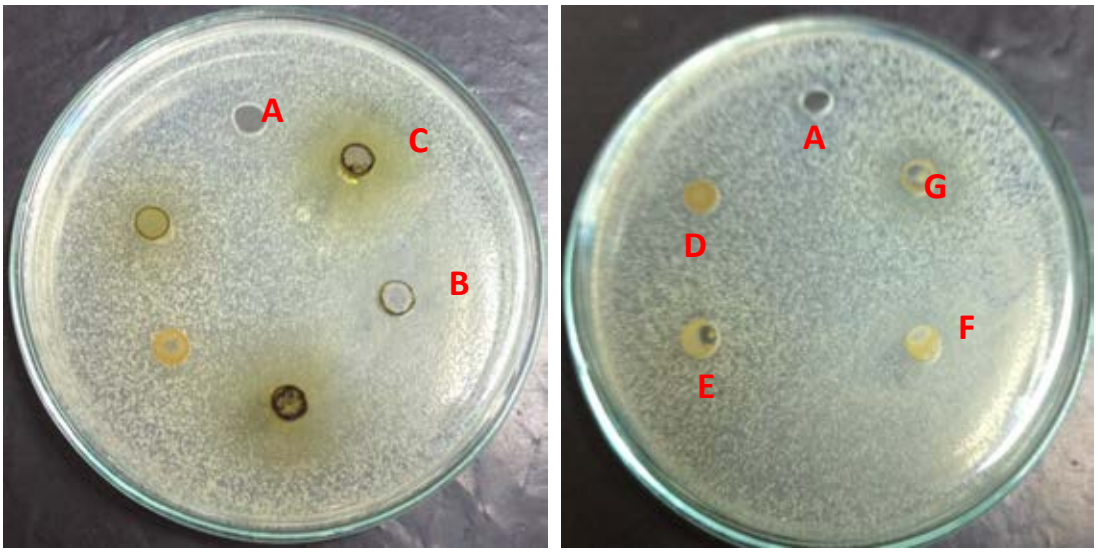


Figure 20 The inhibition zone of *Candida albicans* from *Sida acuta* Burm. f.: **A.** DMSO **B.** dichloromethane extract of leaves, **C.** methanolic extract of leaves, **D.** dichloromethane extract of roots, E. methanolic extract of roots, F. dichloromethane extract of stem, G. methanolic extract of stems

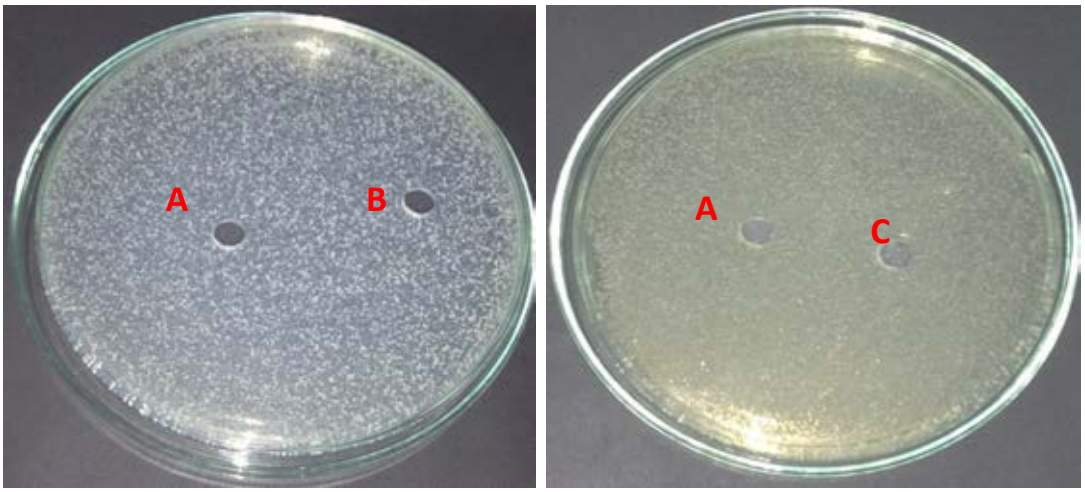


Figure 20 The inhibition zone of *Candida albicans* (cont.) from **A.** DMSO **B.** Ampicillin sodium, **C.** Amikacin sulfate

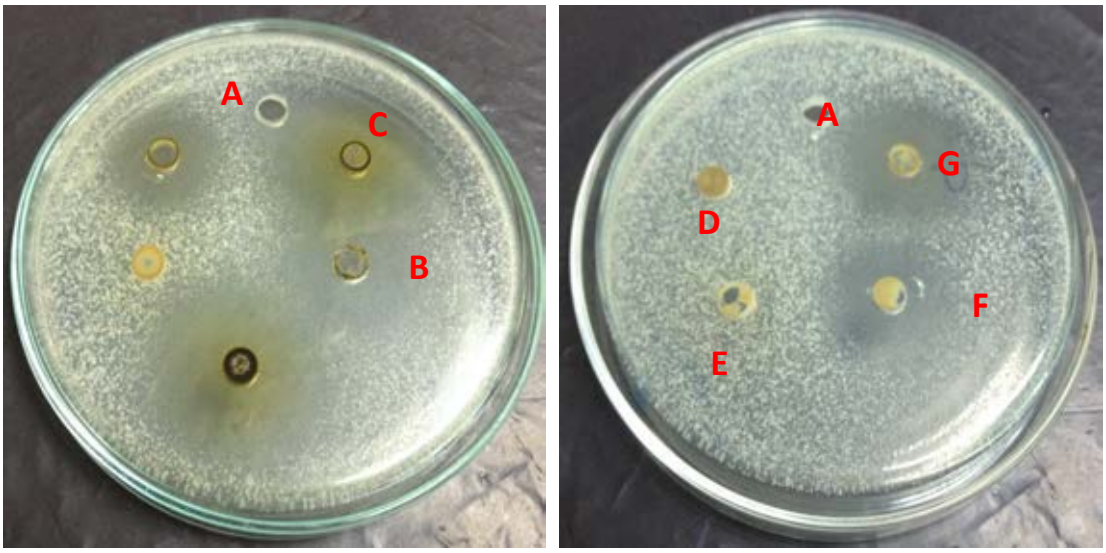


Figure 21 The inhibition zone of *Saccharomyces cerevisiae* from *Sida acuta* Burm. f.: **A.** DMSO **B.** dichloromethane extract of leaves, **C.** methanolic extract of leaves, **D.** dichloromethane extract of roots, E. methanolic extract of roots, F. dichloromethane extract of stem, G. methanolic extract of stems

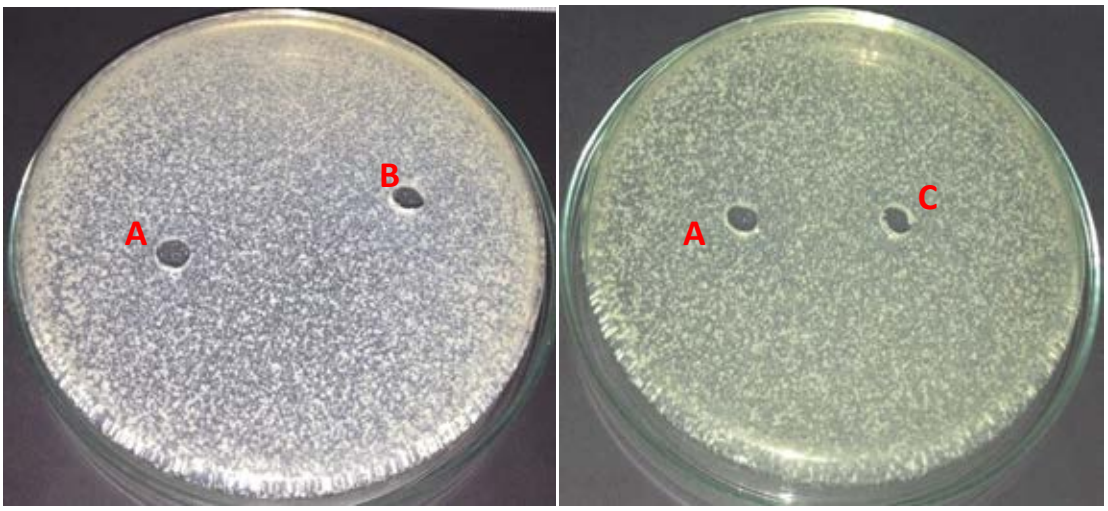


Figure 21 The inhibition zone of *Saccharomyces cerevisiae* (cont.) from **A.** DMSO **B.** Ampicillin sodium, **C.** Amikacin sulfate

APPENDIX B

Table 23% Inhibition of methanolic extracts of *S. acuta* leaves on *P. falciparum* K1

Isolate	Negative	100.00	50.00	25.00	12.50	Control (µg/ml)		6.25	3.13	1.56	0.78
Fluorescent	5.21748	4.17825	4.36982	4.60858	4.92551	13.8979	13.8887	5.97689	11.9317	12.3125	13.0689
	5.08896	4.07488	4.24565	4.56796	4.95815	14.0483	14.7846	5.89055	12.3669	12.6772	11.9761
	4.76271	3.93491	4.17974	4.54468	4.67294	14.3601	14.3135	5.24236	11.0726	11.0305	10.6924
Average	5.02	4.06	4.27	4.57	4.85	14.22		5.70	11.79	12.01	11.91
Average nagative	0.00	-0.96	-0.76	-0.45	-0.17	9.19		0.68	6.77	6.98	6.89
Growth	0.00	-0.10	-0.08	-0.05	-0.02	1.00		0.07	0.74	0.76	0.75
% Growth	0.00	-10.45	-8.25	-4.89	-1.86	100.00		7.40	73.62	75.97	74.95
%Inhibition	100.00	110.45	108.25	104.89	101.86	0.00		92.60	26.38	24.03	25.05

Table 24% Inhibition of dichloromethane extracts of *S. acuta* roots on *P. falciparum*K1

Isolate	Negative	100.00	50.00	25.00	12.50	Control (µg/ml)		6.25	3.13	1.56	0.78
Fluorescent	5.77883	4.17825	8.88514	13.0513	14.4748	15.278	16.9679	14.7618	16.1859	15.8055	15.5091
	5.42981	6.11322	9.41058	13.5372	14.6657	15.1366	16.9385	14.5677	15.8025	15.7551	14.6671
	5.09445	5.97262	9.33292	13.2043	13.9761	14.3115	14.3964	12.1885	13.0642	14.0604	14.2438
Average	5.43	6.08	9.21	13.26	14.37	15.50		13.84	15.02	15.21	14.81
Average negative	0.00	0.65	3.78	7.83	8.94	10.07		8.40	9.58	9.77	9.37
Growth	0.00	0.06	0.37	0.78	0.89	1.00		0.83	0.95	0.97	0.93
% Growth	0.00	6.44	37.49	77.75	88.75	100.00		83.46	95.16	97.04	93.07
% Inhibition	100.00	93.56	62.51	22.25	11.25	0.00		16.54	4.84	2.96	6.93

Table 25% Inhibition of methanolic extracts of *S. acuta* stems on *P. falciparum* 3D7

Isolate	Negative	100.00	50.00	25.00	12.50	Control (µg/ml)		6.25	3.13	1.56	0.78
Fluorescent	5.73386	5.57116	5.81801	9.60795	13.2674	16.0094	16.5854	15.3859	15.0608	15.2132	11.0773
	5.56753	5.44734	5.76439	9.7213	13.2231	16.6539	16.5107	14.5408	14.4618	14.4182	11.4861
	5.24505	5.52343	5.69473	9.6094	12.9945	14.7386	15.4095	13.9191	13.9987	13.1508	10.5747
Average	5.52	5.51	5.76	9.65	13.16	15.98		14.62	14.51	14.26	11.05
Aver negative	0.00	0.00	0.24	4.13	7.65	10.47		9.10	8.99	8.75	5.53
Growth	0.00	0.00	0.02	0.39	0.73	1.00		0.87	0.86	0.84	0.53
% Growth	0.00	-0.01	2.33	39.46	73.04	100.00		86.92	85.89	83.53	52.83
% Inhibition	100.00	100.01	97.67	60.54	26.96	0.00		13.08	14.11	16.47	47.17

Table 26% Inhibition of methanolic extracts of *S. acuta* leaves on*P. falciparum* 3D7

Isolate	Negative	100.00	50.00	25.00	12.50	Control (µg/ml)		6.25	3.13	1.56	0.78
Fluorescent	4.31903	3.61656	3.57261	3.91025	4.14091	10.7602	10.2591	5.12821	8.19085	10.4414	9.51658
	4.39508	3.68918	3.88304	3.95798	4.09175	12.2092	10.0428	6.8558	8.7553	10.6147	10.8382
	4.64167	3.74364	3.89127	4.11109	3.97793	12.1186	11.9917	5.06531	9.68226	10.8437	10.1338
Average	4.45	3.68	3.78	3.99	4.07	11.23		5.68	8.88	10.63	10.16
Average negative	0.00	-0.77	-0.67	-0.46	-0.38	6.78		1.23	4.42	6.18	5.71
Growth	0.00	-0.11	-0.10	-0.07	-0.06	1.00		0.18	0.65	0.91	0.84
% Growth	0.00	-11.34	-9.88	-6.77	-5.63	100.00		18.16	65.27	91.19	84.25
% Inhibition	100.00	111.34	109.88	106.77	105.63	0.00		81.84	34.73	8.81	15.75

Table 27% Inhibition of dichloromethane extracts of *S. acuta* roots on *P. falciparum* 3D7

Isolate	Negative	100.00	50.00	25.00	12.50	Control (µg/ml)		6.25	3.13	1.56	0.78
Fluorescent	4.7473	4.84753	5.93197	7.48959	9.13067	9.29876	10.0871	10.3481	10.3776	11.0648	10.1435
	4.937	5.10793	5.94895	8.32452	10.3184	11.7582	12.0954	12.6573	12.1598	12.3686	11.1942
	4.76622	5.13722	5.98417	8.25723	10.5682	12.678	13.2371	12.1064	13.0339	12.5581	11.6105
Average	4.82	5.03	5.96	8.02	10.01	11.53		11.70	11.86	12.00	10.98
Average nagative	0.00	0.21	1.14	3.21	5.19	6.71		6.89	7.04	7.18	6.17
Growth	0.00	0.03	0.17	0.48	0.77	1.00		1.03	1.05	1.07	0.92
%Growth	0.00	3.19	16.97	47.80	77.34	100.00		102.66	104.94	107.03	91.91
%Inhibition	100.00	96.81	83.03	52.20	22.66	0.00		-2.66	-4.94	-7.03	8.09

Table 28% Inhibition of methanolic extracts of *S. acuta* stems on *P. falciparum* 3D7

Isolate	Negative	100.00	50.00	25.00	12.50	Control (µg/ml)		6.25	3.13	1.56	0.78
Fluorescent	4.53745	4.4253	4.48782	6.81828	9.21532	9.92187	11.7913	10.4189	9.63321	8.42465	9.03924
	4.78693	4.48135	4.55346	6.48745	9.48668	11.7517	11.6252	11.5055	11.3045	11.7832	9.30364
	4.86229	4.74818	4.61495	6.56559	9.69631	11.9643	12.0539	12.3007	11.0625	10.7784	8.68599
Average	4.73	4.55	4.55	6.62	9.47	11.52		11.41	10.67	10.33	9.01
Averagenegative	0.00	-0.18	-0.18	1.89	4.74	6.79		6.68	5.94	5.60	4.28
Growth	0.00	-0.03	-0.03	0.28	0.70	1.00		0.98	0.87	0.82	0.63
% Growth	0.00	-2.61	-2.60	27.91	69.78	100.00		98.38	87.46	82.48	63.05
% Inhibition	100.00	102.61	102.60	72.09	30.22	0.00		1.62	12.54	17.52	36.95

Table 29% Inhibition of *S. acuta*whole plant alkaloids on *P. falciparum*K1

Isolate	Negative	100.00	50.00	25.00	12.50	Control (µg/ml)		6.25	3.13	1.56	0.78
Fluorescent	4.79989	4.5573	5.00252	6.62172	8.95915	9.88672	10.6246	8.37756	5.25635	5.13143	8.83545
	4.07976	4.68422	4.48765	6.10042	7.97757	12.1296	10.7326	8.58021	7.12336	9.24892	11.122
	3.38779	4.81718	4.84268	6.35661	7.7243	11.7444	11.0985	4.93311	9.87037	11.1061	11.1454
Average	4.09	4.69	4.78	6.36	8.22	11.04		7.30	7.42	8.50	10.37
Average negative	0.00	0.60	0.69	2.27	4.13	6.95		3.21	3.33	4.41	6.28
Growth	0.00	0.09	0.10	0.33	0.59	1.00		0.46	0.48	0.63	0.90
%Growth	0.00	8.59	9.91	32.68	59.47	100.00		46.18	47.90	63.43	90.38
%Inhibition	100.00	91.41	90.09	67.32	40.53	0.00		53.82	52.10	36.57	9.62

Table 30% Inhibition of *S. acuta*whole plant alkaloids on *P. falciparum* 3D7

Isolate	Negative	100.00	50.00	25.00	12.50	Control (µg/ml)		6.25	3.13	1.56	0.78
Fluorescent	4.40811	5.07759	5.1686	5.79285	10.7509	13.6538	13.1018	12.22	10.2401	10.4305	11.8951
	4.90697	5.13523	5.35604	5.68947	10.6082	11.0821	11.512	10.058	12.9009	10.1839	12.216
	4.93831	5.09133	5.18874	5.63934	8.44938	10.8878	14.3782	6.08823	10.6495	13.4198	10.1058
Average	4.75	5.10	5.24	5.71	9.94	12.44		9.46	11.26	11.34	11.41
Average negative	0.00	0.35	0.49	0.96	5.19	7.68		4.70	6.51	6.59	6.65
Growth	0.00	0.05	0.06	0.12	0.67	1.00		0.61	0.85	0.86	0.87
% Growth	0.00	4.56	6.33	12.44	67.47	100.00		61.22	84.74	85.80	86.59
% Inhibition	100.00	95.44	93.67	87.56	32.53	0.00		38.78	15.26	14.20	13.41

Table 31 Yeast alpha-glucosidase inhibition of dichloromethane extracts of *S. acuta* leaves

Dichloromethane extracts of *S. acuta* leaves (mg/ml)	OD_{405} (reaction mixture)			Yeast alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	1.702	1.711	1.680					
0.6	1.430	1.400	1.492	29.2	31.7	25.4	28.8	3.2
1.3	1.423	1.473	1.461	45.9	41.2	43.4	43.5	2.4
2.5	1.453	1.568	1.586	64.1	64.6	65.5	64.7	0.7
5.0	2.105	2.002	1.998	89.0	94.8	91.6	91.8	2.9
10.0	2.566	2.231	2.532	92.5	95.1	95.4	94.3	1.6

Dichloromethane extracts of *S. acuta* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.092	0.109	0.084
0.6	0.290	0.306	0.302
1.3	0.552	0.531	0.557
2.5	0.875	1.001	1.036
5.0	1.928	1.919	1.864
10.0	2.446	2.152	2.459

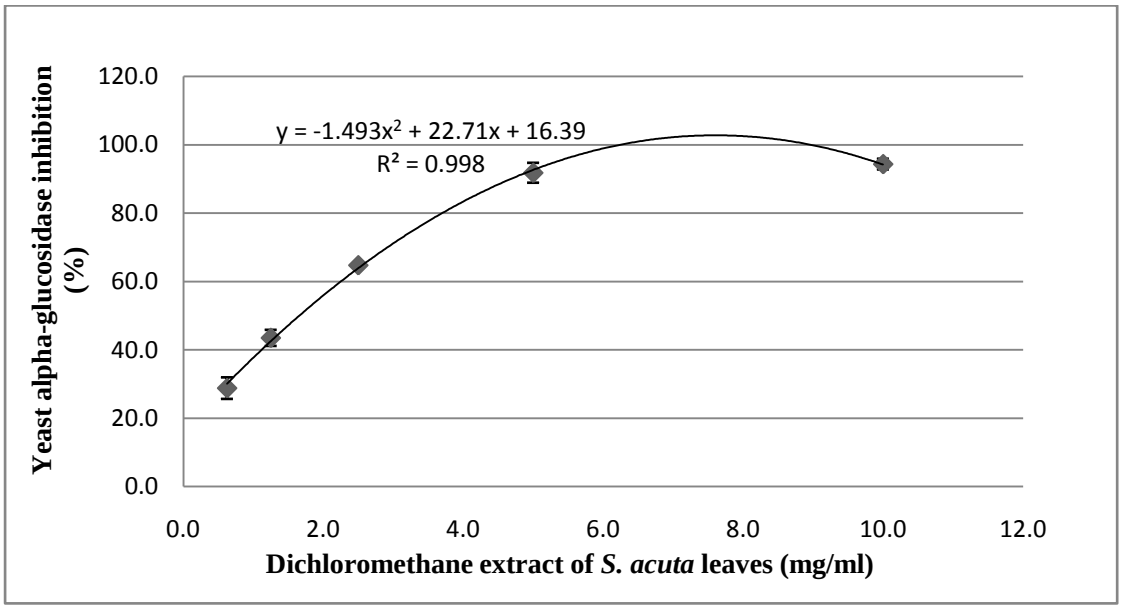


Figure 22 Yeast alpha-glucosidase inhibition of dichloromethane extract of *S. acuta* leaves.

Table 32 Yeast alpha-glucosidase inhibition of methanolic extracts of *S. acuta* leaves

Methanolic extracts of *S. acuta* leaves (mg/ml)	OD_{405} (reaction mixture)			Yeast alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	1.685	1.711	1.663					
0.6	1.663	1.707	1.7	16.9	7.1	11.0	11.7	4.9
1.3	1.689	1.689	1.614	30.4	25.3	32.2	29.3	3.6
2.5	1.702	1.709	1.716	54.5	52.5	52.0	53.0	1.3
5.0	1.756	1.761	1.78	83.2	89.7	85.9	86.3	3.2
10.0	1.832	1.829	1.851	99.3	101.1	101.0	100.4	1.0

Methanolic extracts of *S. acuta* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.074	0.086	0.105
0.6	0.325	0.3	0.314
1.3	0.568	0.558	0.558
2.5	0.969	0.99	0.968
5.0	1.486	1.605	1.561
10.0	1.82	1.845	1.867

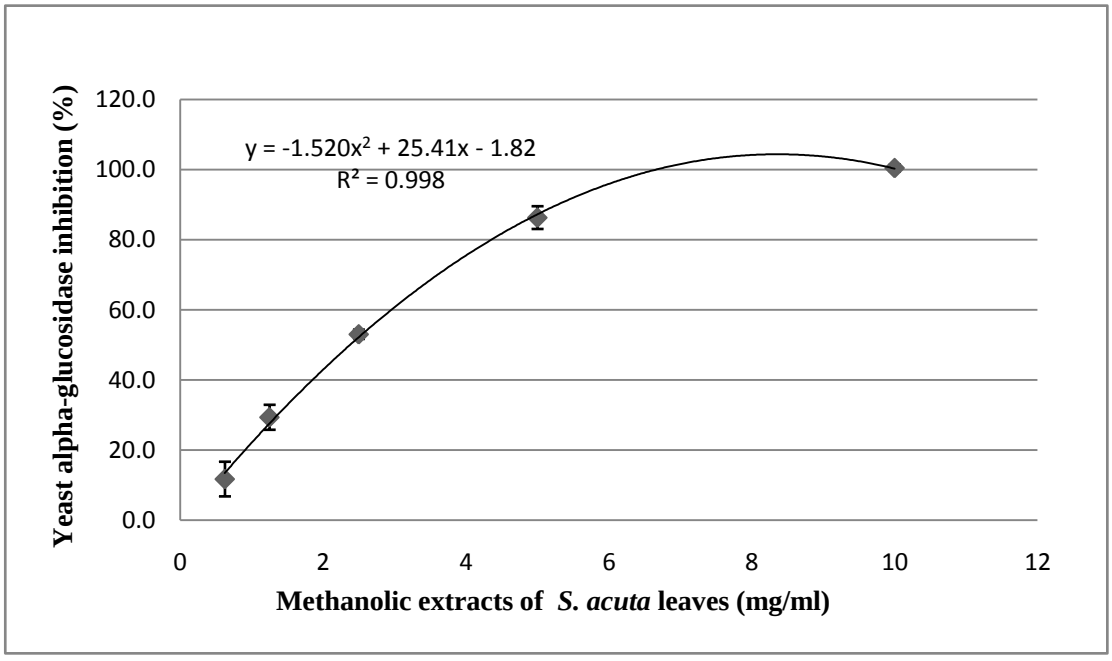


Figure 23 Yeast alpha-glucosidase inhibition of methanolic extracts of *S. acuta* leaves

Table 33 Yeast alpha-glucosidase inhibition of dichloromethane extracts of S. acuta roots

Dichloromethane extract of *S. acuta* roots (mg/ml)	OD_{405} (reaction mixture)			Yeast alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	1.701	1.545	1.255					
0.3	1.512	1.451	1.201	14.3	9.6	7.3	10.4	3.6
0.6	1.326	1.279	1.123	26.3	22.2	17.0	21.9	4.7
1.3	1.211	1.043	0.804	38.2	42.6	50.7	43.8	6.3
2.5	0.815	0.748	0.531	75.8	75.3	74.7	75.3	0.6
5.0	0.715	0.715	0.693	94.8	96.3	96.3	95.8	0.8
10.0	1.169	1.125	1.058	104.0	112.8	123.6	113.5	9.8

Dichloromethane extract of *S. acuta* roots (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.08	0.074	0.073
0.3	0.122	0.121	0.105
0.6	0.132	0.135	0.142
1.3	0.21	0.199	0.221
2.5	0.423	0.385	0.232
5.0	0.631	0.66	0.649
10.0	1.234	1.313	1.337

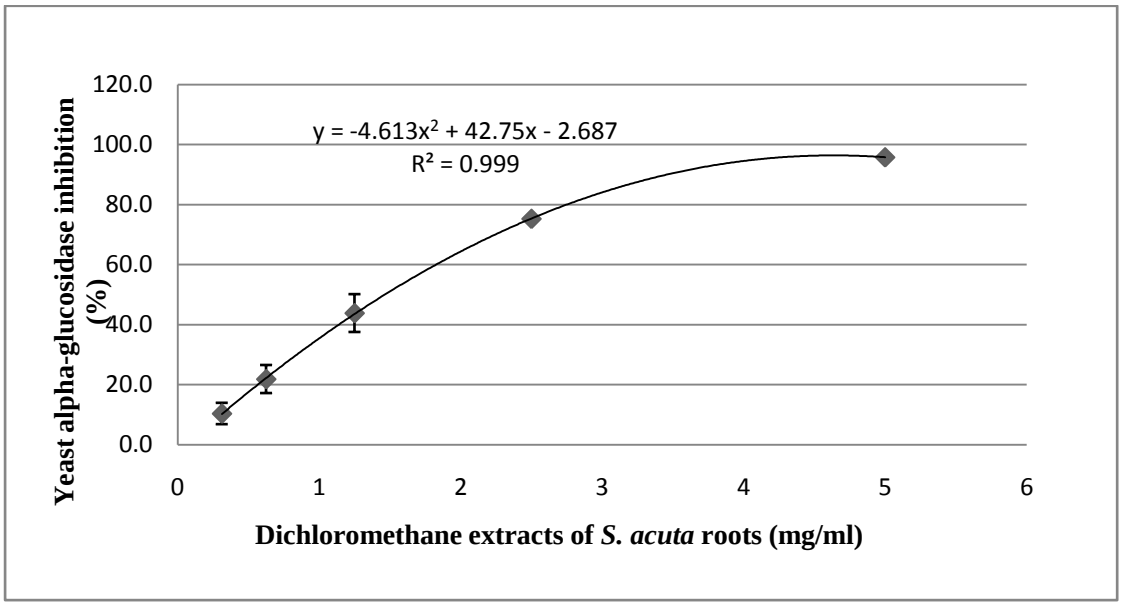


Figure 24 Yeast alpha-glucosidase inhibition of dichloromethane extract of *S. acuta* roots

Table 34 Yeast alpha-glucosidase inhibition of methanolic extracts of *S. acuta* roots

Methanolic extracts of *S. acuta* roots (mg/ml)	OD_{405} (reaction mixture)			Yeast alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	1.702	1.711	1.680					
0.6	1.726	1.673	1.671	-0.1	3.0	3.0	2.0	1.8
1.3	1.676	1.669	1.704	6.5	6.2	3.9	5.5	1.4
2.5	1.644	1.639	1.653	11.6	11.0	10.2	10.9	0.7
5.0	1.594	1.661	1.466	24.1	21.5	31.8	25.8	5.3
10.0	1.119	1.228	1.213	69.6	64.9	67.9	67.5	2.4

Methanolic extracts of *S. acuta* roots (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.092	0.109	0.084
0.6	0.115	0.119	0.123
1.3	0.17	0166	0.17
2.5	0.22	0.213	0.219
5.0	0.372	0.403	0.377
10.0	0.63	0.666	0.7

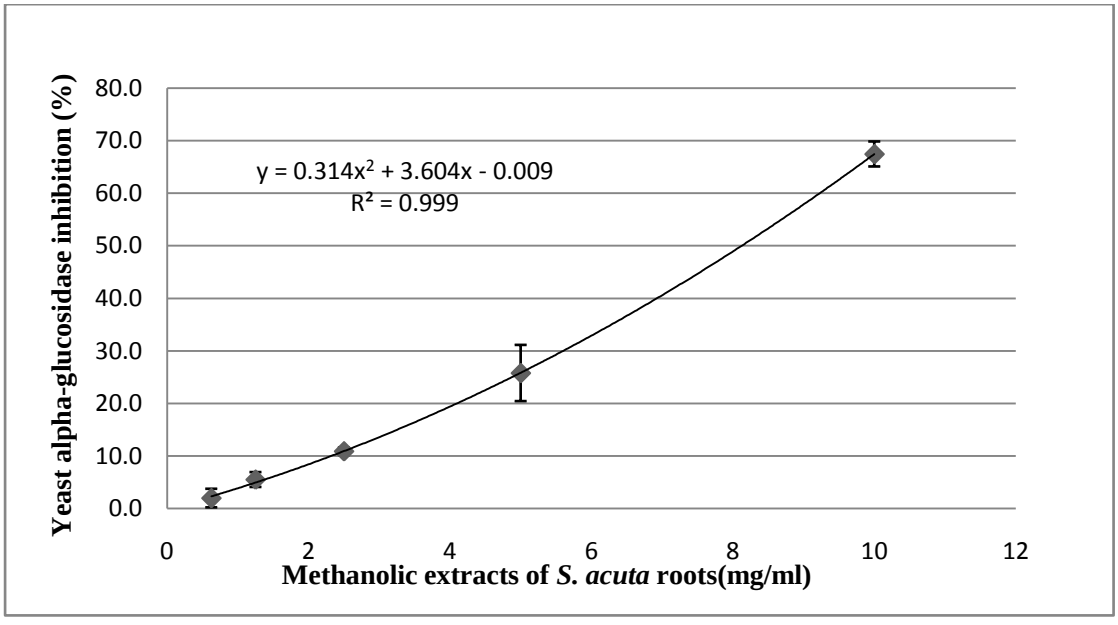


Figure 25 Yeast alpha-glucosidase inhibition of methanolic extracts of *S. acuta* roots

Table 35 Yeast alpha-glucosidase inhibition of dichloromethane extracts of *S. acuta* stems

Dichloromethane extracts of *S. acuta* stems (mg/ml)	OD_{405} (reaction mixture)			Yeast alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	1.685	1.601	1.663					
0.6	1.302	1.18	1.138	29.3	32.6	36.8	32.9	3.7
1.3	1.104	0.993	1.105	46.0	48.2	43.4	45.9	2.4
2.5	1.094	0.834	0.892	62.8	67.5	66.3	65.5	2.4
5.0	0.792	0.815	0.746	87.5	87.1	89.2	87.9	1.1
10.0	1.358	1.243	1.269	100.0	96.7	91.9	96.2	4.1

Dichloromethane extracts of *S. acuta* stems (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.074	0.086	0.105
0.6	0.163	0.159	0.153
1.3	0.234	0.208	0.223
2.5	0.495	0.341	0.367
5.0	0.591	0.619	0.577
10.0	1.358	1.193	1.143

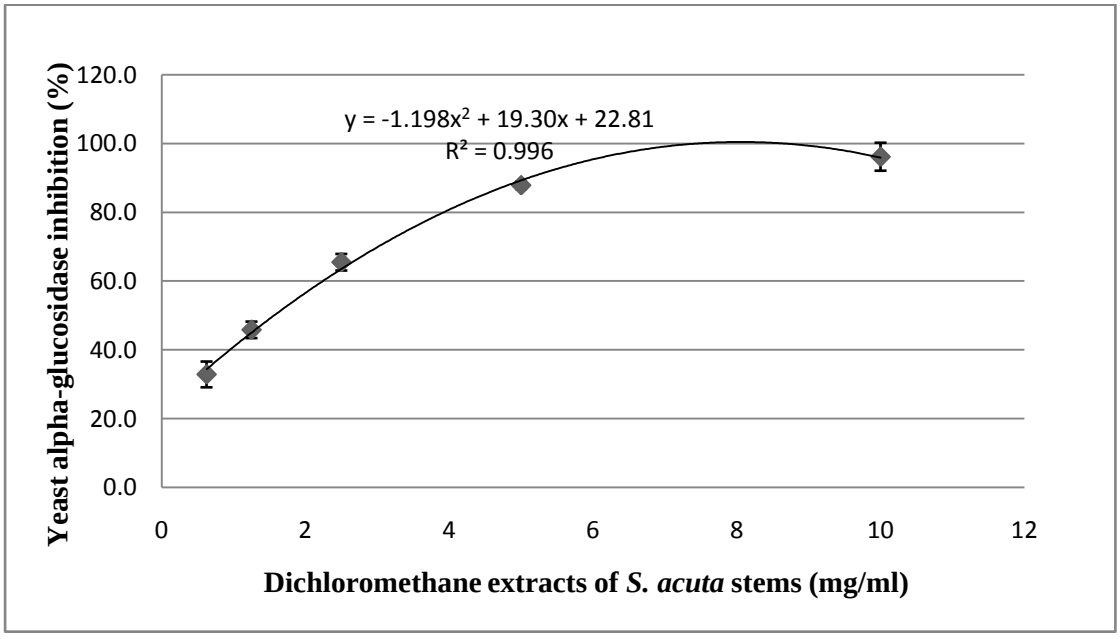


Figure 26 Yeast alpha-glucosidase inhibition of dicholoromethane extracts of *S. acuta* stems

Table 36 Yeast alpha-glucosidase inhibition of methanolic extracts of *S. acuta* stems

Methanolic extracts of *S. acuta* stems (mg/ml)	OD_{405} (reaction mixture)			Yeast alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	1.685	1.601	1.663					
0.6	1.637	1.572	1.586	5.9	5.1	5.9	5.7	0.4
1.3	1.603	1.509	1.509	9.9	10.5	13.5	11.3	1.9
2.5	1.503	1.441	1.496	22.8	21.7	20.0	21.5	1.4
5.0	1.346	1.305	1.309	42.4	42.0	43.4	42.6	0.7
10.0	0.938	0.96	1.08	90.3	85.5	78.6	84.8	5.8

Methanolic extracts of *S. acuta* stems (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.074	0.086	0.105
0.6	0.121	0.135	0.12
1.3	0.151	0153	0.161
2.5	0.26	0.254	0.25
5.0	0.418	0.427	0.427
10.0	0.781	0.74	0.747

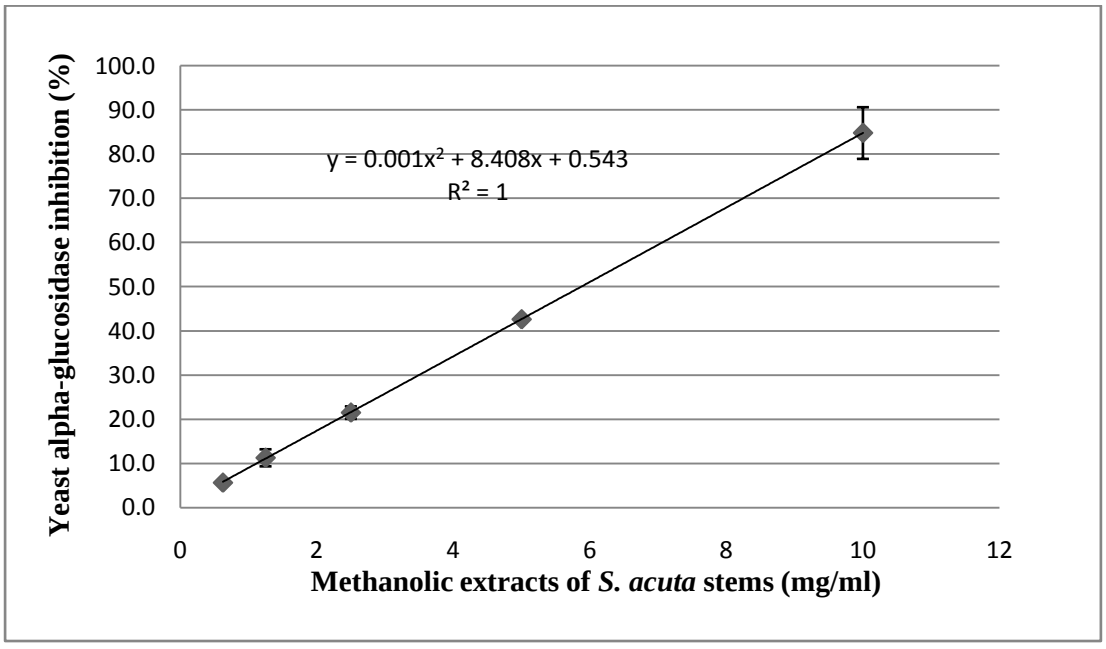


Figure 27 Yeast alpha-glucosidase inhibition of methanolic extracts of *S. acuta* stems

Table 37 Yeast alpha-glucosidase inhibition of dichloromethane extracts of *M. coromandelianum* leaves

Dichloromethane extracts of *M. coromandelianum* leaves (mg/ml)	OD_{405} (reaction mixture)			Yeast alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	1.534	1.617	1.393					
0.3	0.534	0.544	0.468	34.6	28.6	28.1	30.5	3.6
0.6	0.561	0.494	0.564	39.2	43.3	40.3	40.9	2.2
1.3	0.907	0.917	0.875	55.9	56.2	55.3	55.8	0.4
2.5	1.501	1.52	1.529	81.5	64.8	68.9	71.7	8.7
5.0	2.167	2.205	2.43	85.2	87.4	74.3	82.3	7.0
10.0	2.908	2.807	2.937	94.1	100.0	87.2	93.8	6.4

Dichloromethane extracts of *M. coromandelianum* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.87	0.98	0.86
0.3	0.1	0.089	0.085
0.6	0.157	0133	0.246
1.3	0.6	0.638	0.637
2.5	1.378	1.296	1.363
5.0	2.069	2.125	2.293
10.0	2.869	2.807	2.869

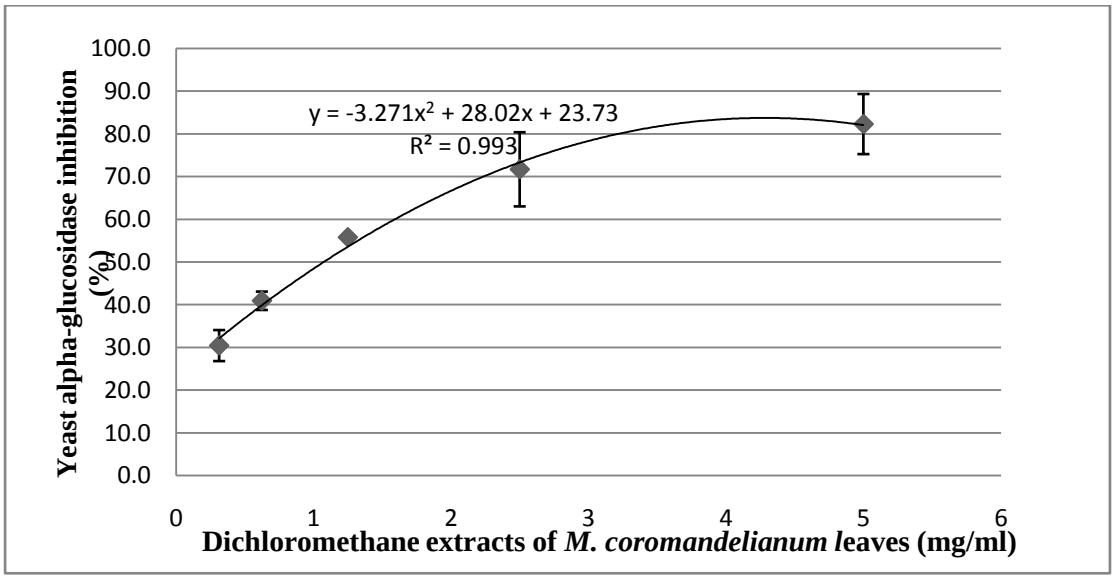


Figure 28 Yeast alpha-glucosidase inhibition of dichloromethane extracts of *M. coromandelianum* leaves

Table 38 Yeast alpha-glucosidase inhibition of methanolic extract of *M coromandelianum* leaves

Methanolic extracts of *M. coromandelianum* leaves (mg/ml)	OD_{405} (reaction mixture)			Yeast alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	1.248	1.402	1.36					
0.6	1.196	1.256	1.237	29.8	30.7	30.9	30.5	0.6
1.3	1.185	1.267	1.217	40.7	41.0	45.6	42.4	2.7
2.5	1.342	1.364	1.381	65.7	62.9	63.8	64.2	1.5
5.0	1.641	1.692	1.654	89.1	88.0	88.1	88.4	0.6
10.0	1.897	1.99	1.977	100.2	99.4	99.6	99.2	0.5

Methanolic extracts of *M. coromandelianum* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.051	0.081	0.061
0.6	0.356	0.341	0.339
1.3	0.475	0.488	0.51
2.5	0.932	0.874	0.911
5.0	1.511	1.534	1.499
10.0	1.899	1.982	1.966

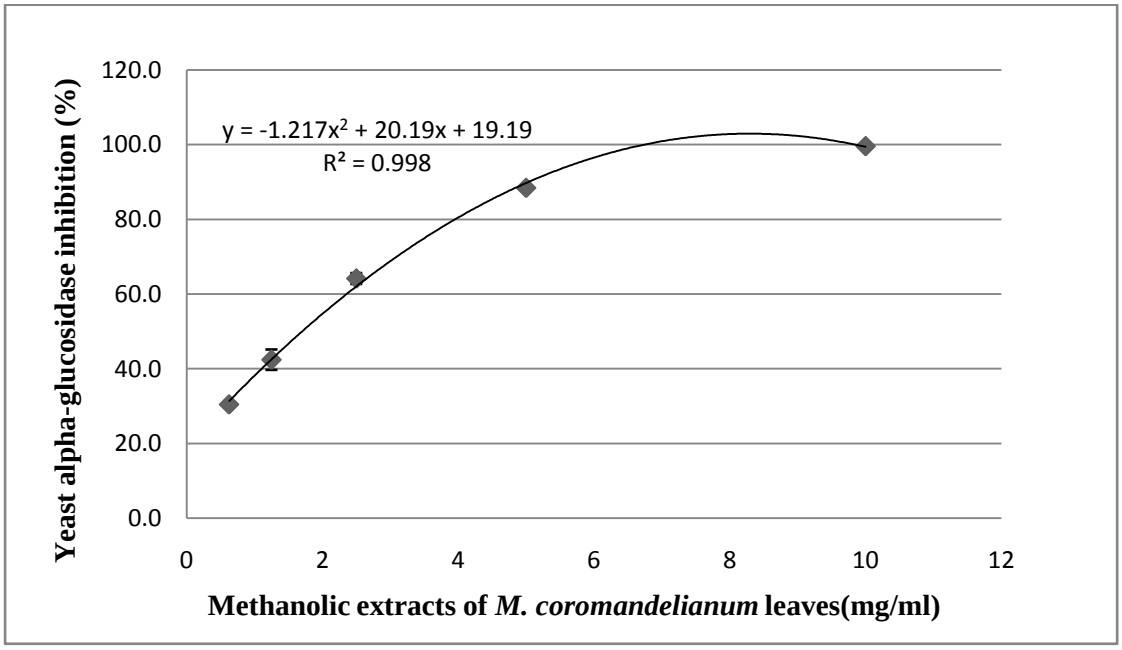


Figure 29 Yeast alpha-glucosidase inhibition of methanolic extracts of *M. coromandelianum* leaves

Table 39 Yeast alpha-glucosidase inhibition of dichloromethane extracts of *M. coromandelianum* roots

Dichloromethane extracts of *M. coromandelianum* roots (mg/ml)	OD_{405} (reaction mixture)			Yeast alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	1.248	1.402	1.36					
0.02	1.056	1.076	1.103	12.7	19.3	15.9	16.0	3.3
0.04	0.988	1.047	1.092	19.0	22.1	17.2	19.5	2.5
0.08	0.891	0.942	0.982	28.3	30.9	26.0	28.4	2.4
0.16	0.788	0.892	0.871	37.8	35.4	36.1	36.5	1.2
0.31	0.752	0.823	0.794	41.4	41.6	43.7	42.2	1.3
0.63	0.665	0.711	0.713	51.2	52.2	50.7	51.4	0.7
1.25	0.531	0.557	0.579	63.7	64.6	62.7	63.7	0.9
2.50	0.467	0.488	0.542	71.2	72.5	69.2	71.0	1.7
5.00	0.312	0.288	0.295	85.0	89.2	91.0	88.4	3.0
10.00	0.461	0.457	0.466	96.7	95.6	95.8	96.1	0.6

Dichloromethane extracts of *M. coromandelianum* roots (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.051	0.081	0.061
0.02	0.011	0.01	0.011
0.04	0.019	0.018	0.017
0.08	0.033	0.029	0.021
0.16	0.044	0.039	0.041
0.31	0.051	0.051	0.063
0.63	0.081	0.079	0.073
1.25	0.097	0.089	0.095
2.50	0.122	0.125	0.142
5.00	0.133	0.145	0.178
10.00	0.422	0.399	0.412

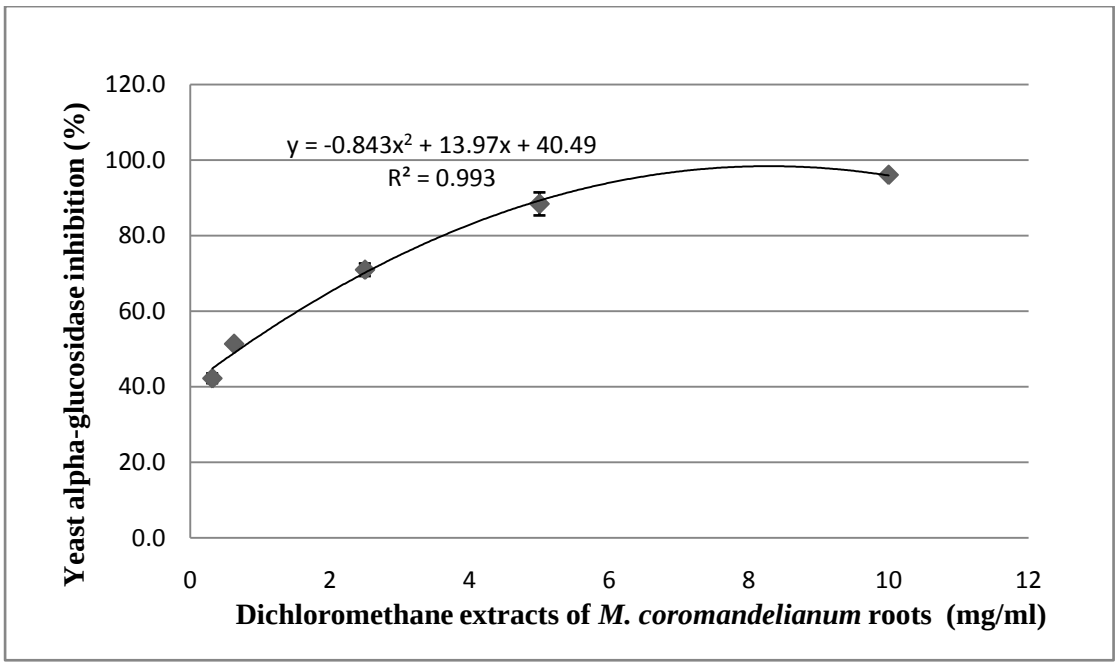


Figure 30 Yeast alpha-glucosidase inhibition of dichloromethane extracts of *M. coromandelianum* roots

Table 40 Yeast alpha-glucosidase inhibition of methanolic extracts of *M. coromandelianum* roots

Methanolic extracts of *M. coromandelianum* roots (mg/ml)	OD_{405} (reaction mixture)			Yeast alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	1.248	1.402	1.36					
0.02	1.191	1.251	1.372	3.7	7.6	-3.4	2.6	5.6
0.04	1.151	1.222	1.231	7.5	10.6	8.2	8.8	1.6
0.08	1.021	1.099	1.11	19.3	20.7	19.3	19.8	0.8
0.16	0.921	0.981	0.998	29.1	31.7	28.3	29.7	1.8
0.31	0.891	0.899	0.911	33.9	38.7	37.5	36.7	2.5
0.63	0.745	0.798	0.781	46.3	48.5	47.7	47.5	1.1
1.25	0.656	0.699	0.678	54.4	57.2	57.4	56.3	1.7
2.50	0.522	0.622	0.641	69.2	64.9	62.7	65.6	3.3
5.00	0.456	0.466	0.447	77.9	76.5	76.2	76.9	0.9
10.00	0.353	0.453	0.456	89.9	84.4	82.8	85.7	3.7

Methanolic extracts of *M. coromandelianum* roots (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.051	0.081	0.061
0.02	0.038	0.031	0.029
0.04	0.044	0.041	0.039
0.08	0.055	0.052	0.062
0.16	0.072	0.079	0.067
0.31	0.1	0.089	0.099
0.63	0.102	0.118	0.102
1.25	0.11	0.134	0.125
2.50	0.153	0.158	0.157
5.00	0.191	0.156	0.138
10.00	0.232	0.247	0.232

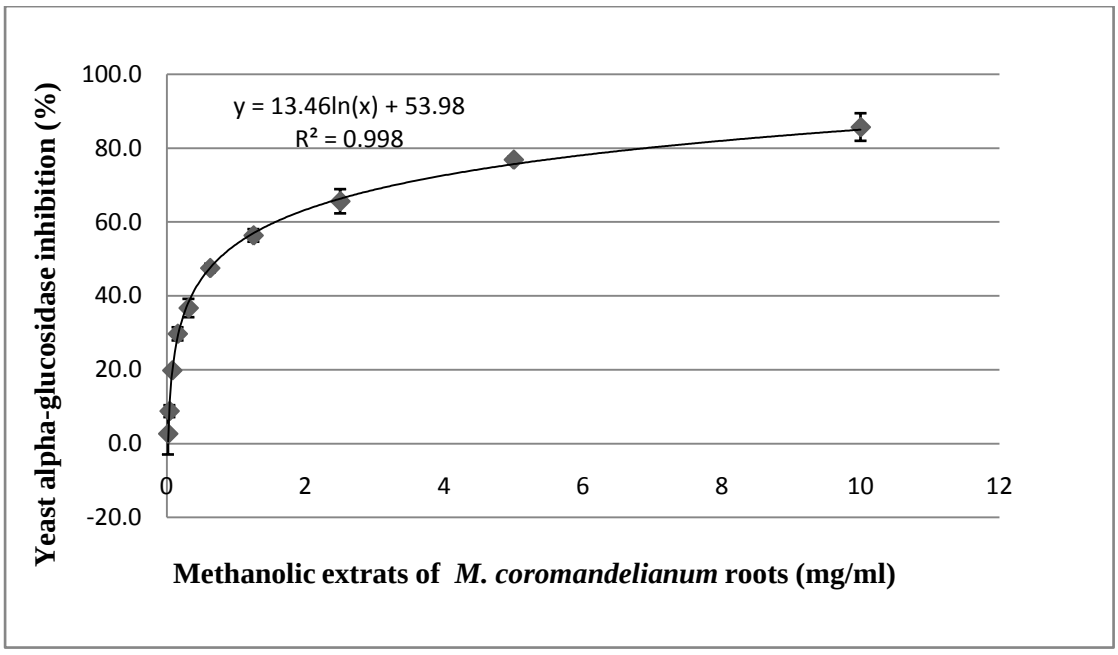


Figure 31 Yeast alpha-glucosidase inhibition of methanolic extracts of *M. coromandelianum* roots

Table 41 Yeast alpha-glucosidase inhibition of dichloromethane extracts of *M. coromandelianum* stems

Dichloromethane extracts of *M. coromandelianum* stems (mg/ml)	OD_{405} (reaction mixture)			Yeast alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	1.177	1.173	0.998					
0.6	1.289	1.301	1.096	3.4	2.5	5.9	3.9	1.8
1.3	1.184	1.212	1.184	19.2	18.2	2.3	13.3	9.5
2.5	1.144	1.27	1.205	39.0	29.7	25.6	31.4	6.9
5.0	1.194	1.228	1.277	67.5	64.7	55.7	62.6	6.1
10.0	1.523	1.387	1.398	92.1	98.3	96.8	95.7	3.3

Dichloromethane extracts of *M. coromandelianum* stems (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.044	0.041	0.04
0.6	0.194	0.197	0.195
1.3	0.269	0.286	0.248
2.5	0.453	0.473	0.492
5.0	0.826	0.826	0.853
10.0	1.433	1.365	1.367

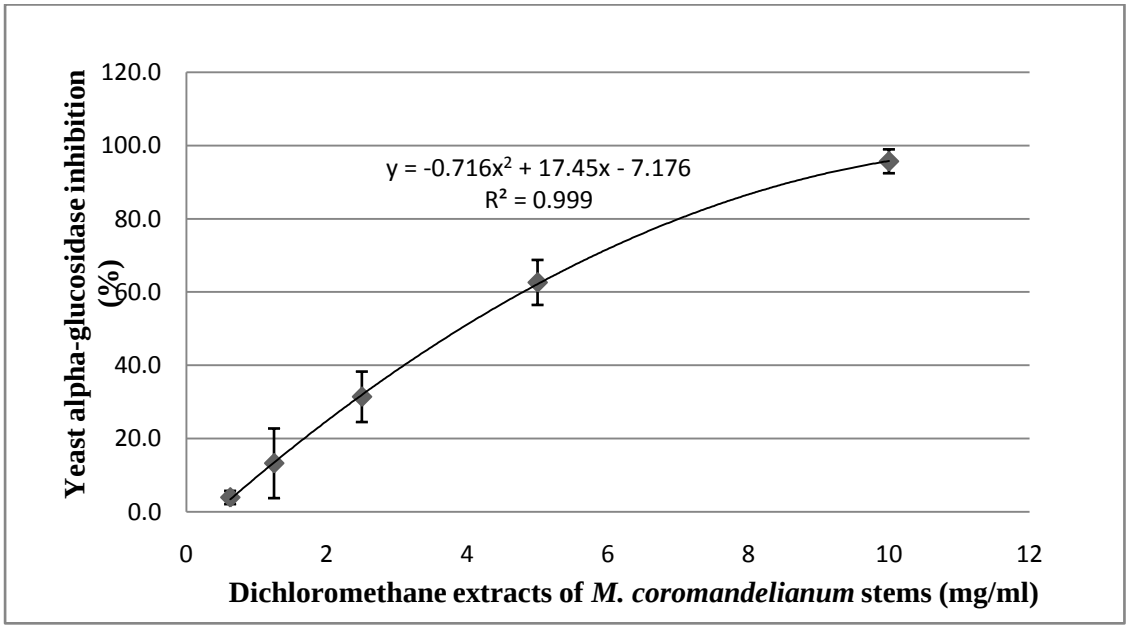


Figure 32 Yeast alpha-glucosidase inhibition of dichloromethane extracts of *M. coromandelianum* stems

Table 42 Yeast alpha-glucosidase inhibition of methanolic extracts of *M. coromandelianum* stems

Methanolic extracts of *M. coromandelianum* roots (mg/ml)	OD_{405} (reaction mixture)			Yeast alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.94	0.998	1.05					
0.08	0.825	0.859	0.907	15.0	15.9	15.1	15.3	0.5
0.16	0.711	0.762	0.845	28.6	27.4	23.0	26.3	3.0
0.31	0.591	0.78	0.624	45.5	31.0	47.1	41.2	8.9
0.63	0.459	0.45	0.354	64.2	67.0	78.2	69.8	7.4
1.25	0.336	0.321	0.313	85.1	86.7	88.2	86.7	1.5
2.50	0.384	0.428	0.391	89.7	88.1	90.2	89.3	1.1
5.00	0.58	0.615	0.616	96.0	93.1	93.5	94.2	1.6
10.00	1.017	0.977	0.991	91.6	94.3	97.9	94.6	3.2

Methanolic extracts of *M. coromandelianum* roots (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.051	0.081	0.061
0.08	0.087	0.084	0.087
0.16	0.091	0.093	0.101
0.31	0.118	0.144	0.113
0.63	0.148	0.146	0.143
1.25	0.207	0.198	0.199
2.50	0.295	0.318	0.296
5.00	0.545	0.551	0.553
10.00	0.944	0.924	0.971

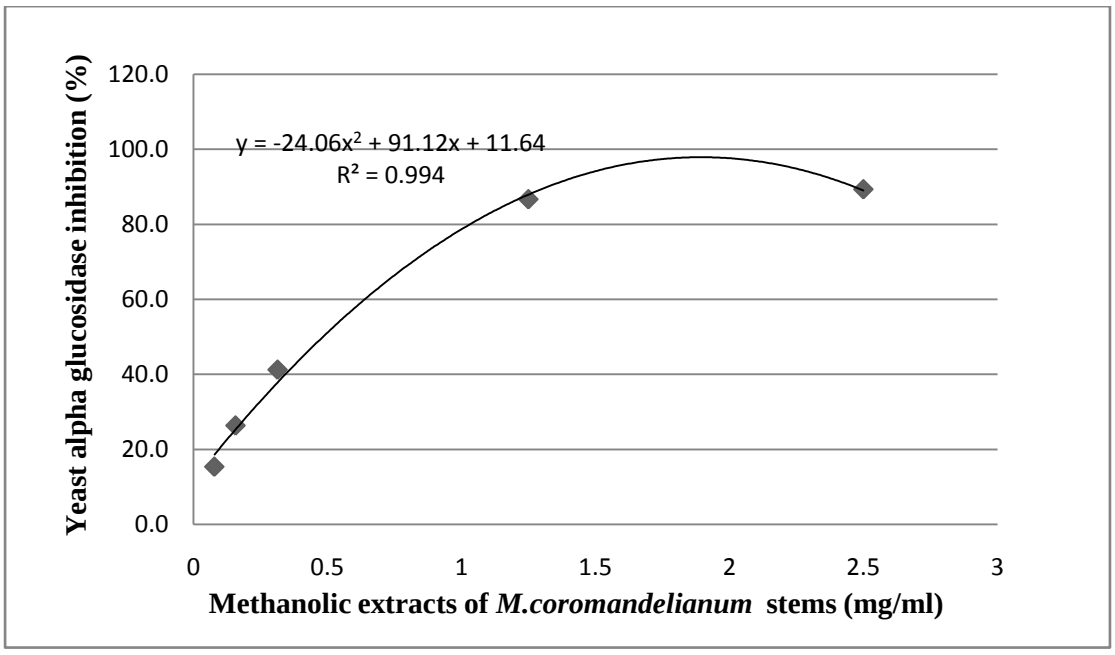


Figure 33 Yeast alpha-glucosidase inhibition of methanolic extracts of *M. coromandelianum* stems

Table 43 Yeast alpha-glucosidase inhibition of dichloromethane extracts of *A. indicum* leaves

Dichloromethane extracts of *A. indicum* leaves (mg/ml)	OD_{405} (reaction mixture)			Yeast alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	1.6	1.571	1.295					
0.02	1.551	1.401	1.141	3.5	2.1	3.8	3.1	0.9
0.04	1.451	1.306	1.021	11.3	9.2	15.3	11.9	3.1
0.08	1.391	1.209	1.001	15.7	16.7	17.2	16.5	0.8
0.16	1.321	1.171	0.999	21.6	19.7	18.3	19.9	1.6
0.31	1.211	1.122	0.912	30.4	24.4	27.3	27.4	3.0
0.63	1.084	0.9	0.797	40.9	40.5	38.5	40.0	1.3
1.25	0.988	0.853	0.786	47.4	44.8	39.3	43.8	4.1
2.50	0.947	0.824	0.742	51.2	47.9	43.8	47.6	3.7
5.00	1.257	0.999	0.857	55.4	50.5	52.5	52.8	2.5
10.00	1.986	1.889	1.839	64.5	58.9	63.9	62.4	3.0

Dichloromethane extracts of *A. indicum* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.19	0.161	0.124
0.02	0.019	0.021	0.015
0.04	0.029	0.026	0.029
0.08	0.031	0.034	0.031
0.16	0.044	0.039	0.041
0.31	0.059	0.056	0.061
0.63	0.079	0.061	0.077
1.25	0.075	0.074	0.075
2.50	0.088	0.089	0.084
5.00	0.457	0.301	0.301
10.00	1.314	1.31	1.416

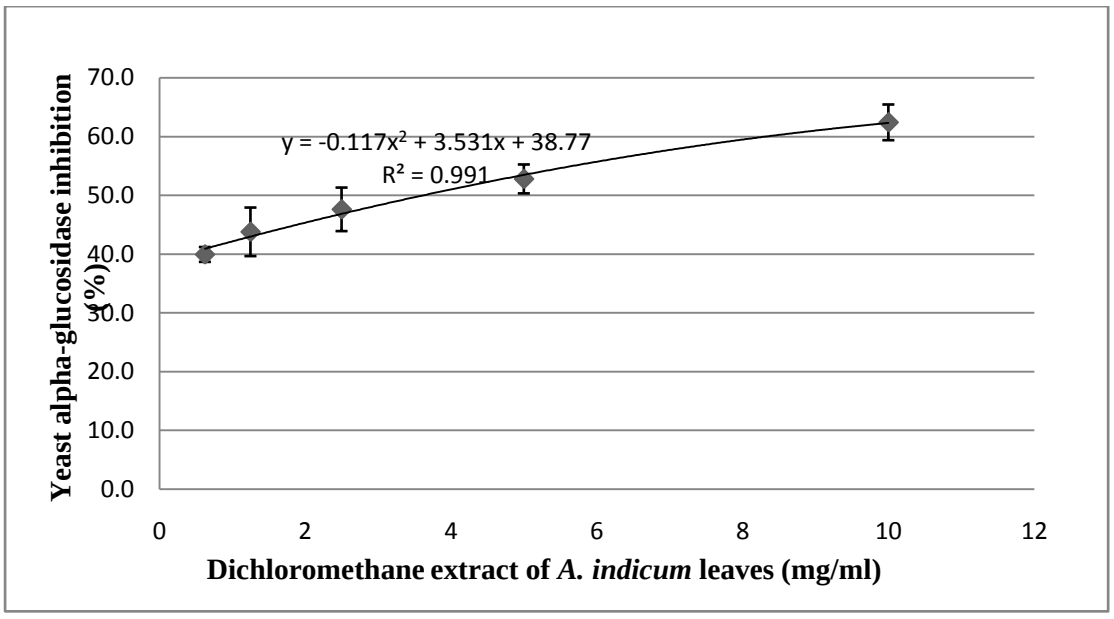


Figure 34 Yeast alpha-glucosidase inhibition of dichloromethane extracts of *A. indicum* leaves

Table 44 Yeast alpha-glucosidase inhibition of methanolic extracts of *A. indicum* leaves

Methanolic extracts of *A. indicum* leaves(mg/ml)	OD_{405} (reaction mixture)			Yeast alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	1.653	1.68	1.693					
0.6	1.738	1.71	1.706	7.8	13.1	13.6	11.5	3.2
1.3	1.755	1.733	1.724	17.5	22.4	21.4	20.5	2.6
2.5	1.753	1.75	1.753	30.9	37.0	36.5	34.8	3.4
5.0	1.778	1.781	1.781	58.6	55.6	53.7	56.0	2.5
10.0	1.906	1.879	1.85	84.2	103.4	97.6	95.1	9.9

Methanolic extracts of *A. indicum* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.067	0.054	0.053
0.6	0.275	0.297	0.289
1.3	0.447	0.472	0.435
2.5	0.657	0.725	0.711
5.0	1.122	1.059	1.021
10.0	1.655	1.935	1.811

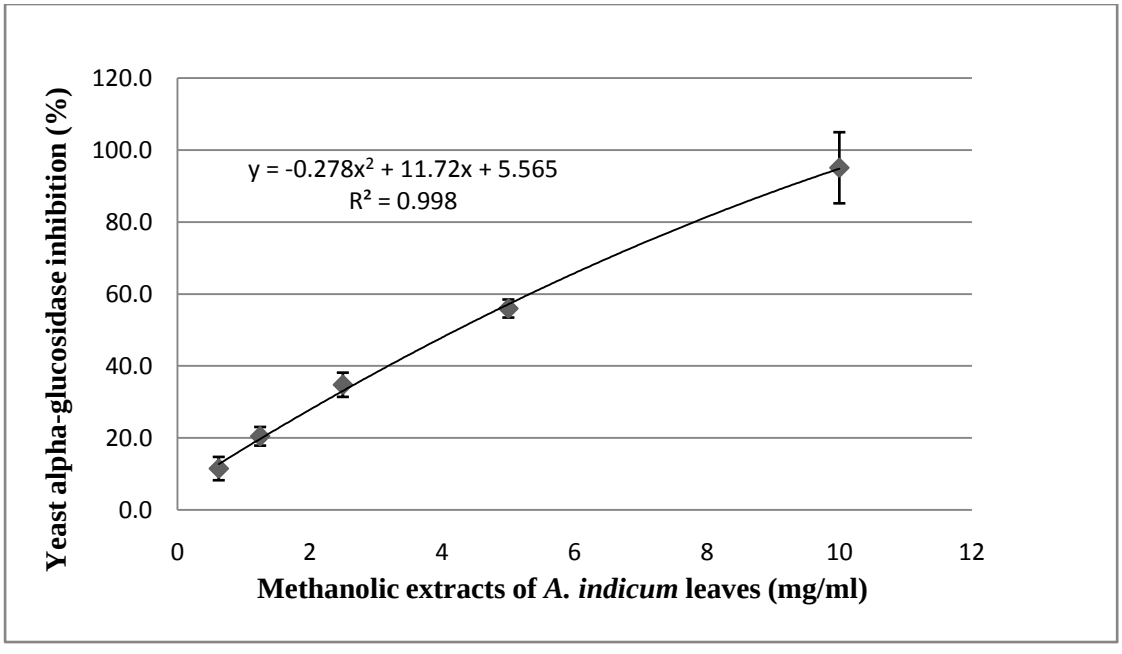


Figure 35 Yeast alpha-glucosidase inhibition of methanolic extracts of *A. indicum* leaves

Table 45 Yeast alpha-glucosidase inhibition of dichloromethane extracts of *A. indicum* roots

Dichloromethane extracts of *A. indicum* roots (mg/ml)	OD_{405} (reaction mixture)			Yeast alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	1.6	1.571	1.295					
0.02	1.521	1.298	1.106	4.8	8.1	6.4	6.4	1.7
0.04	1.433	1.201	1.001	11.3	16.7	16.1	14.7	3.0
0.08	1.322	1.124	0.958	20.8	22.3	20.8	21.3	0.8
0.16	1.215	1.123	0.908	30.6	24.2	27.5	27.4	3.2
0.31	0.965	0.835	0.733	49.4	47.7	44.7	47.3	2.4
0.63	0.841	0.684	0.65	61.9	59.6	56.8	59.4	2.6
1.25	0.705	0.516	0.398	73.7	72.9	76.9	74.5	2.1
2.50	0.396	0.222	0.151	97.0	96.8	95.5	96.4	0.8
5.00	0.657	0.485	0.543	101.3	102.7	96.0	100.0	3.5
10.00	1.049	0.801	1.692	116.5	116.2	116.1	116.3	0.2

Dichloromethane extracts of *A. indicum* roots (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.19	0.161	0.124
0.02	0.007	0.002	0.01
0.04	0.012	0.027	0.019
0.08	0.034	0.028	0.031
0.16	0.066	0.054	0.059
0.31	0.081	0.098	0.085
0.63	0.133	0.114	0.144
1.25	0.163	0.134	0.128
2.50	0.183	0.177	0.098
5.00	0.505	0.523	0.496
10.00	1.11	1.029	1.881

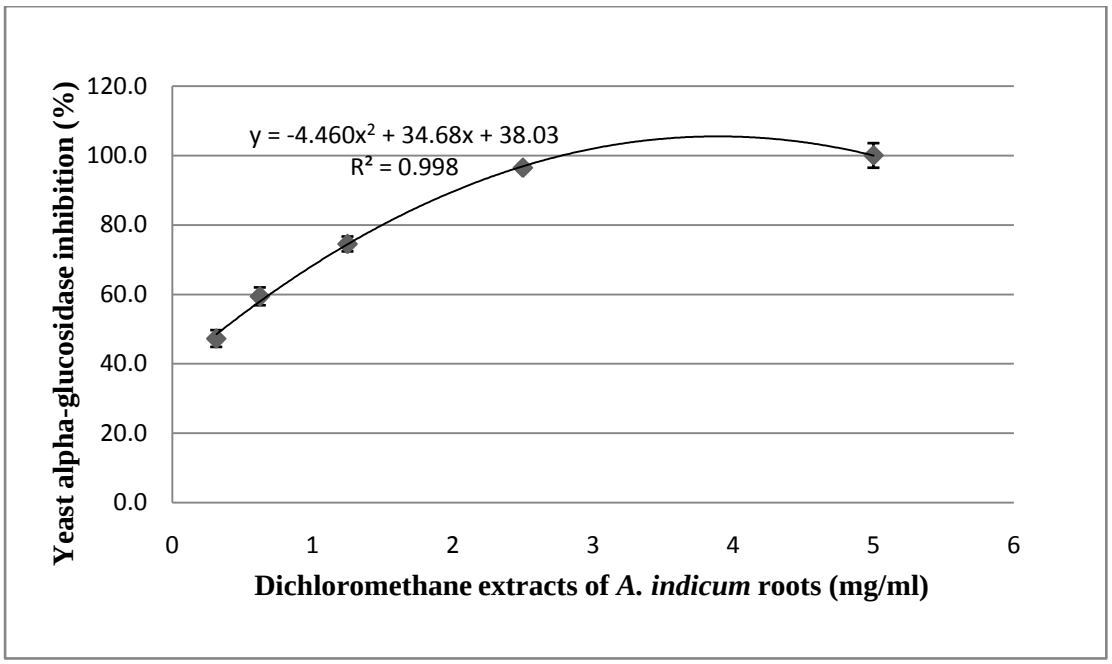


Figure 36 Yeast alpha-glucosidase inhibition of dichloromethane extract of *A. indicum* roots

Table 46 Yeast alpha-glucosidase inhibition of methanolic extracts of *A. indicum* roots

Methanolic extracts of *A. indicum* roots(mg/ml)	OD_{405} (reaction mixture)			Yeast alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	1.653	1.68	1.693					
0.6	1.093	1.019	0.993	38.1	36.4	39.0	37.8	1.3
1.3	0.936	0.815	0.798	48.9	50.3	51.7	50.3	1.4
2.5	0.699	0.711	0.625	66.7	60.5	66.9	64.7	3.6
5.0	0.455	0.398	0.383	83.3	81.0	82.9	82.4	1.2
10.0	0.342	0.289	0.199	97.2	92.2	97.5	95.6	3.0

Methanolic extracts of *A. indicum* roots (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.125	0.113	0.102
0.6	0.034	0.023	0.022
1.3	0.042	0.036	0.029
2.5	0.077	0.092	0.098
5.0	0.087	0.101	0.111
10.0	0.187	0.166	0.159

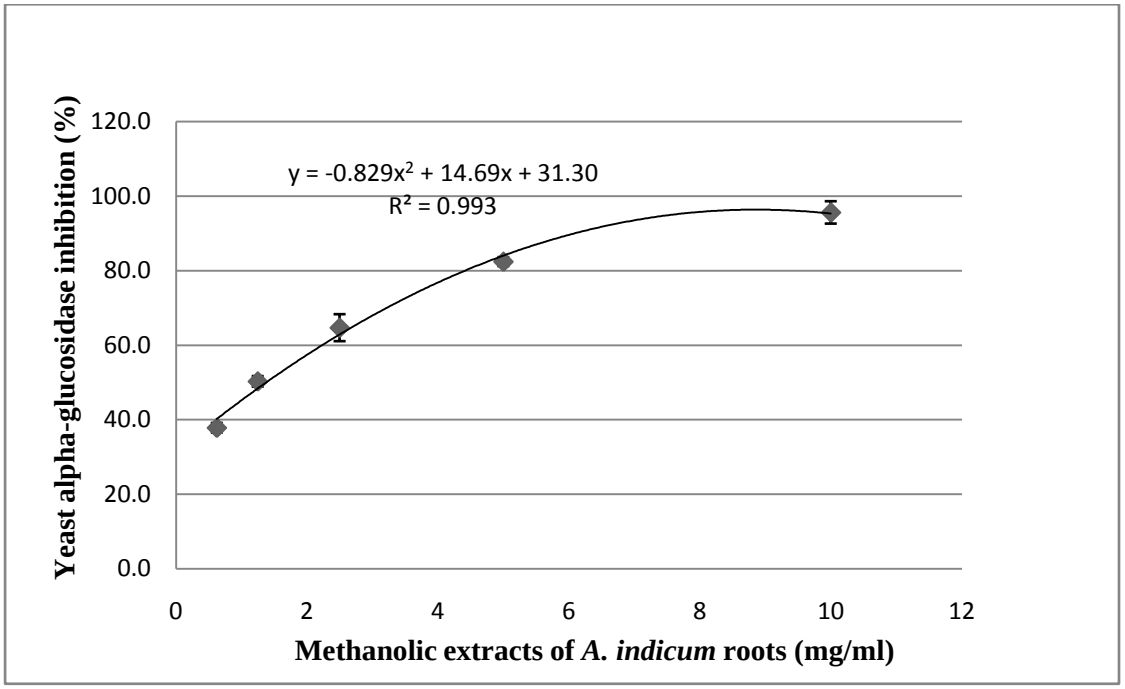


Figure 37 Yeast alpha-glucosidase inhibition of methanolic extracts of *A. indicum* roots

Table 47 Yeast alpha-glucosidase inhibition of dichloromethane extracts of *A. indicum* stems

Dichloromethane extracts of *A. indicum* stems (mg/ml)	OD_{405} (reaction mixture)			Yeast alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	1.653	1.68	1.693					
0.02	1.368	1.311	1.423	19.7	18.3	12.5	16.8	3.8
0.04	1.218	1.221	1.262	30.9	24.9	23.0	26.3	4.1
0.08	1.099	1.071	1.007	39.8	35.0	40.5	38.4	3.0
0.16	0.998	0.991	0.911	47.2	41.4	47.8	45.4	3.6
0.31	0.982	0.985	0.864	49.1	43.5	51.9	48.1	4.3
0.63	0.889	0.878	0.884	56.3	51.6	50.8	52.9	2.9
1.25	0.825	0.797	0.867	61.9	57.2	54.1	57.7	4.0
2.50	0.751	0.871	0.686	79.0	64.3	74.9	72.7	7.6
5.00	0.757	0.664	0.713	89.0	87.3	82.5	86.3	3.3
10.00	0.857	0.877	0.787	100.8	90.1	94.4	95.1	5.4

Dichloromethane extracts of *A. indicum* stems (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.125	0.113	0.102
0.02	0.028	0.03	0.031
0.04	0.049	0.044	0.037
0.08	0.066	0.052	0.061
0.16	0.078	0.072	0.081
0.31	0.091	0.099	0.099
0.63	0.108	0.12	0.102
1.25	0.131	0.127	0.136
2.50	0.318	0.311	0.287
5.00	0.476	0.465	0.435
10.00	0.756	0.722	0.698

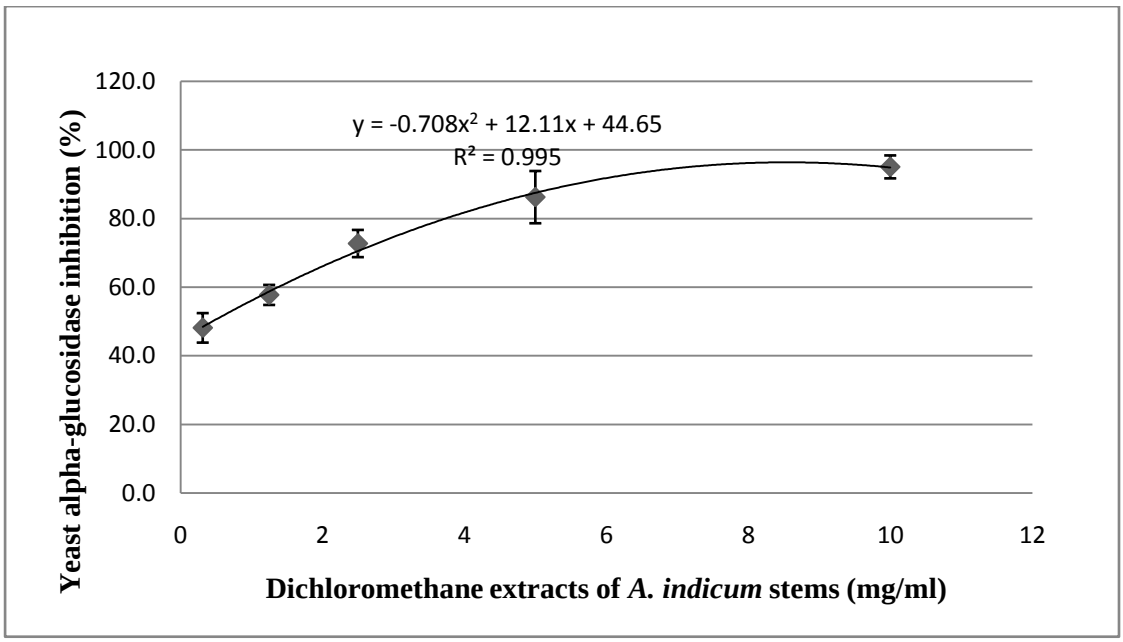


Figure 38 Yeast alpha-glucosidase inhibition of dichloromethane extracts of *A. indicum* stems

Table 48 Yeast alpha-glucosidase inhibition of methanolic extracts of *A. indicum* stems

Methanolic extracts of *A. indicum* stems (mg/ml)	**OD_{405} (reaction mixture)**			**Yeast alpha-glucosidase inhibition (%)**				
	exp 1	**exp 2**	**exp 3**	**exp 1**	**exp 2**	**exp 3**	**Mean**	**SD**
0.00	1.653	1.68	1.693					
0.02	1.429	1.469	1.498	8.2	8.2	7.7	8.0	0.3
0.04	1.421	1.429	1.498	10.4	11.9	9.2	10.5	1.4
0.08	1.311	1.342	1.399	18.7	18.6	16.0	17.8	1.5
0.16	1.191	1.192	1.199	27.5	29.2	30.0	28.9	1.3
0.31	1.098	1.073	1.078	33.7	38.5	39.1	37.1	2.9
0.63	0.977	0.972	0.967	42.0	45.7	48.3	45.3	3.2
1.25	0.896	0.877	0.897	51.1	54.6	51.1	52.3	2.0
2.50	0.963	0.982	0.975	57.3	61.8	63.7	61.0	3.3
5.00	0.882	0.893	0.955	72.5	74.5	72.3	73.1	1.3
10.00	0.858	0.822	0.861	81.1	86.2	84.7	84.0	2.6

Methanolic extracts of *A. indicum* stems (mg/ml)	**OD_{405} (blank)**		
	exp 1	**exp 2**	**exp 3**
0.00	0.125	0.113	0.102
0.02	0.03	0.031	0.029
0.04	0.058	0.049	0.053
0.08	0.079	0.066	0.063
0.16	0.098	0.083	0.085
0.31	0.103	0.11	0.109
0.63	0.112	0.121	0.144
1.25	0.175	0.166	0.119
2.50	0.341	0.384	0.397
5.00	0.499	0.494	0.514
10.00	0.611	0.606	0.618

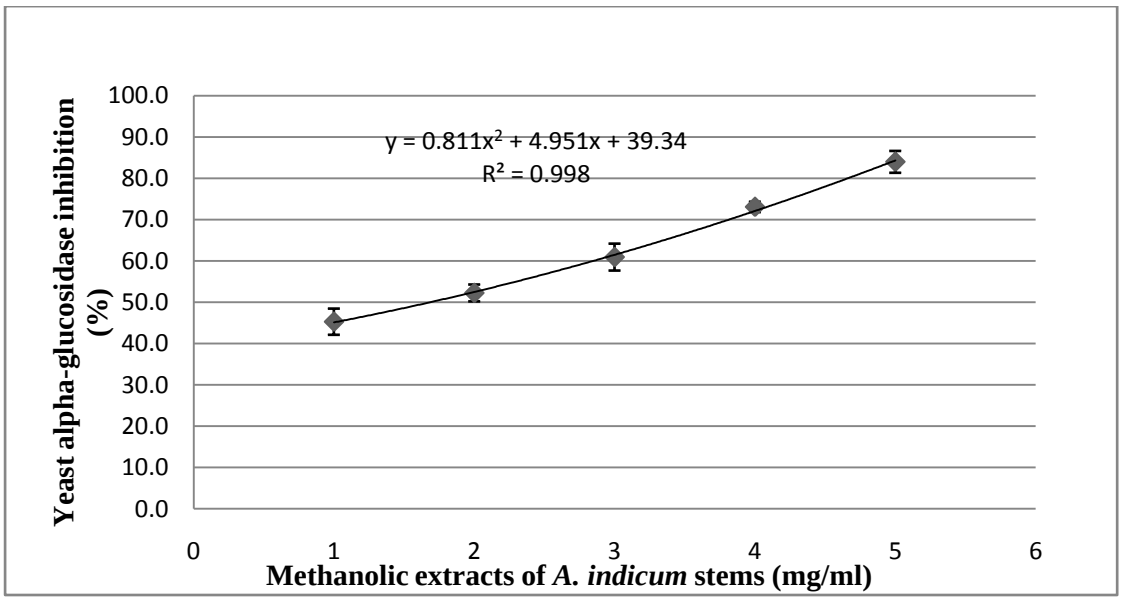


Figure 39 Yeast alpha-glucosidase inhibition of methanolic extracts of *A. indicum* stems

Table 49 Yeast alpha- glucosidase inhibition of 1-Deoxynojirimycin

1-Deoxynojirimycin (mg/ml)	OD_{405} (reaction mixture)			Yeast alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	1.679	1.658	1.683					
0.09	1.433	1.348	1.426	12.4	6.7	13.1	10.7	3.5
0.187	1.241	1.236	1.341	28.1	16.5	19.7	21.4	6.0
0.375	1.115	0.984	1.104	37.9	35.9	35.2	36.3	1.4
0.75	0.904	0.538	0.782	54.0	67.5	56.5	59.3	7.2
1.5	0.328	0.254	0.193	97.7	90.0	94.3	94.0	3.9

1-Deoxynojirimycin (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.1	0.081	0.085
0.09	0.05	0.032	0.038
0.187	0.056	0.059	0.058
0.375	0.068	0.08	0.069
0.75	0.084	0.08	0.087
1.5	0.125	0.113	0.102

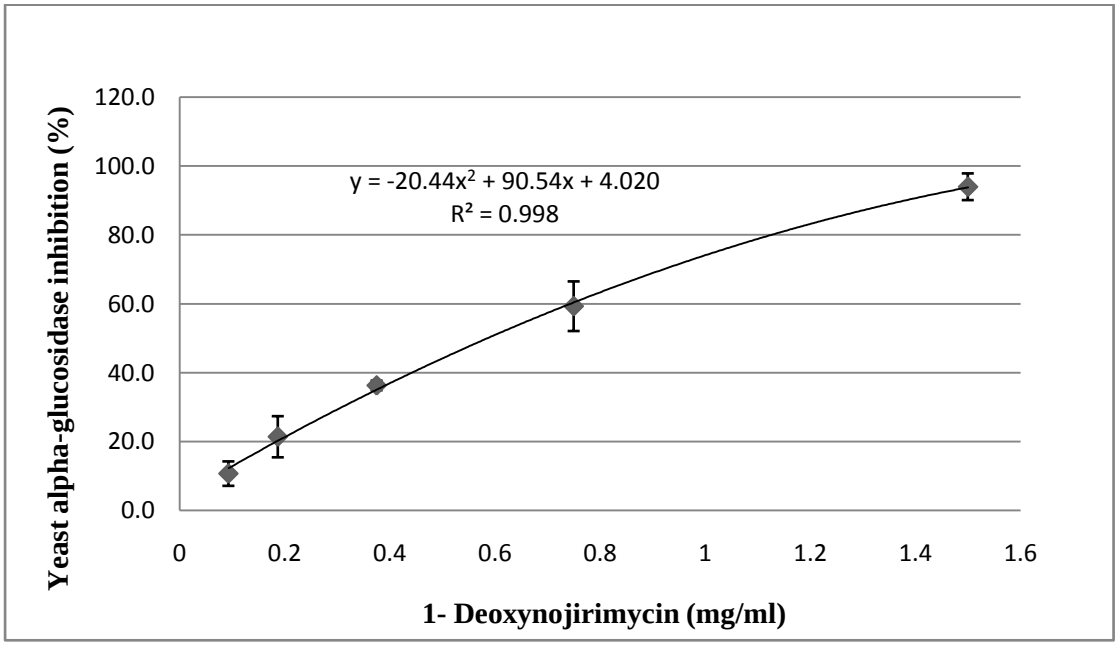


Figure 40 Yeast alpha-glucosidase inhibition of 1-Deoxynojirimycin

Table 50 Alpha-amylase inhibition of dichloromethane extracts of *S. acuta* leaves

Dichloromethane extracts of *S. acuta* leaves(mg/ml)	OD_{405} (reaction mixture)			Alpha-amylase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	0.523	0.501	0.521					
0.6	0.312	0.315	0.333	35.5	37.0	38.6	37.0	1.6
1.3	0.284	0.312	0.329	46.5	41.5	45.0	44.3	2.6
2.5	0.262	0.272	0.275	59.7	55.6	56.3	57.2	2.2
5.0	0.219	0.213	0.212	71.7	73.5	74.7	73.3	1.6
10.0	0.134	0.132	0.141	97.0	95.3	98.2	96.8	1.4

Dichloromethane extracts of *S. acuta* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.089	0.055	0.034
0.6	0.032	0.034	0.034
1.3	0.052	0.051	0.061
2.5	0.087	0.074	0.062
5.0	0.096	0.095	0.089
10.0	0.121	0.111	0.132

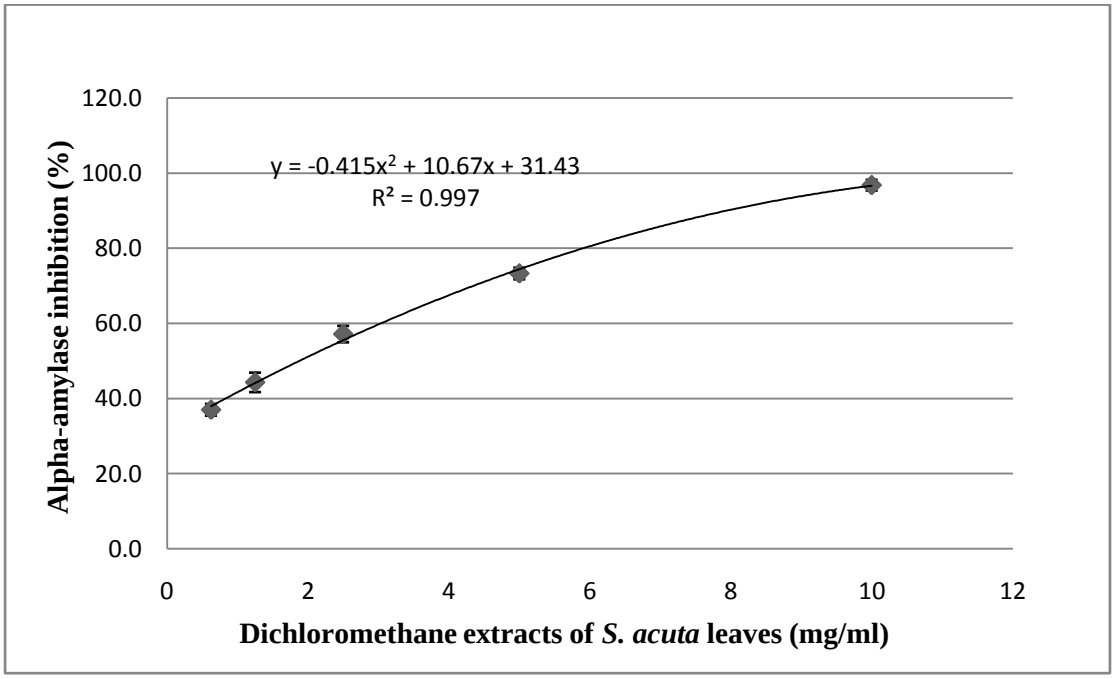
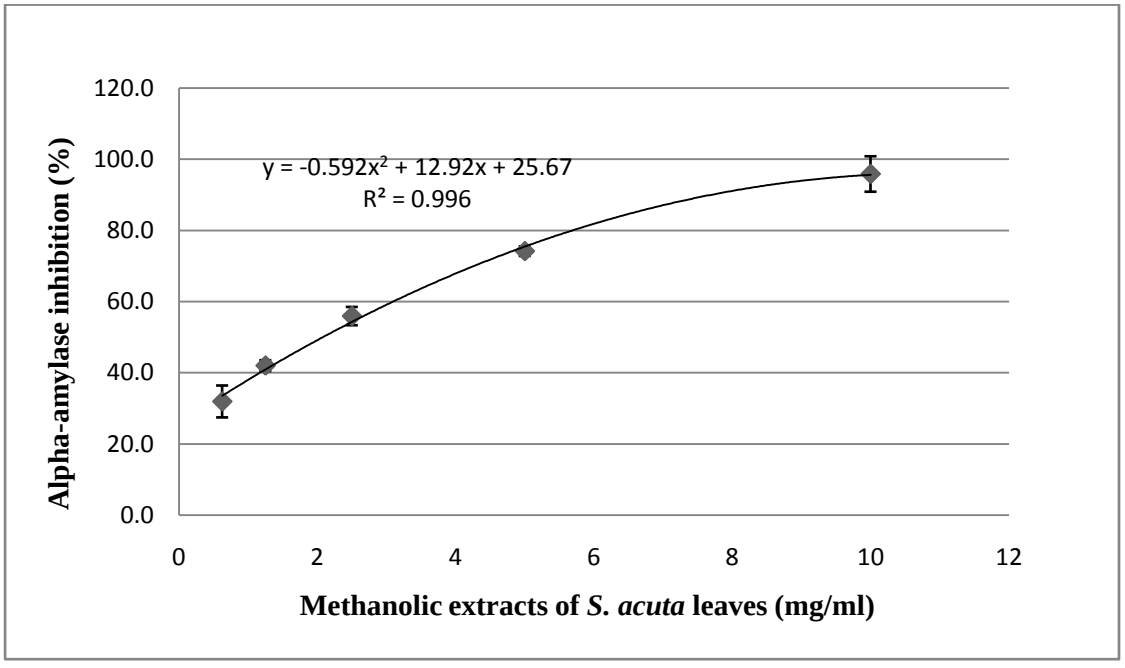


Figure 41 Alpha-amylase inhibition of dichloromethane extracts of *S. acuta* leaves

Table 51 Alpha-amylase inhibition of methanolic extracts of *S. acuta* leaves

Methanolic extracts of *S. acuta* leaves(mg/ml)	OD_{405} (reaction mixture)			Alpha-amylase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	0.523	0.501	0.521					
0.6	0.392	0.323	0.421	30.2	37.0	28.5	31.9	4.5
1.3	0.349	0.378	0.448	43.1	42.6	40.2	42.0	1.5
2.5	0.514	0.449	0.562	56.2	58.3	53.2	55.9	2.6
5.0	0.527	0.532	0.544	74.0	75.6	72.9	74.1	1.3
10.0	0.554	0.535	0.536	90.1	98.4	99.0	95.8	5.0

Methanolic extracts of *S. acuta* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.089	0.055	0.034
0.6	0.089	0.042	0.073
1.3	0.102	0.122	0.157
2.5	0.324	0.313	0.334
5.0	0.414	0.423	0.412
10.0	0.511	0.528	0.531



Fugure 42 Alpha-amylase inhibition of methanolic extracts of *S. acuta* leaves

Table 52 Alpha-amylase inhibition of dichloromethane extracts of *S. acuta* roots

Dichloromethane extracts of *S. acuta* roots (mg/ml)	OD_{405} (reaction mixture)			Alpha-amylase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.774	0.788	0.722					
0.02	0.701	0.722	0.782	1.0	-7.4	-12.1	-6.2	6.6
0.04	0.696	0.671	0.677	1.8	0.6	3.0	1.8	1.2
0.08	0.632	0.632	0.622	11.0	6.4	11.5	9.6	2.8
0.16	0.582	0.572	0.612	18.2	15.8	13.5	15.8	2.4
0.31	0.498	0.501	0.499	30.6	27.3	29.4	29.1	1.7
0.63	0.422	0.325	0.336	41.6	55.5	52.5	49.8	7.3
1.25	0.322	0.385	0.356	60.0	46.4	53.9	53.4	6.8
2.50	0.306	0.335	0.312	65.9	58.6	63.6	62.7	3.7
5.00	0.266	0.365	0.367	77.2	63.2	61.4	62.7	8.7
10.00	0.327	0.261	0.221	91.1	88.3	95.7	91.7	3.7

Dichloromethane extracts of *S. acuta* roots (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.067	0.118	0.025
0.02	0.001	0.003	0.001
0.04	0.002	0.005	0.001
0.08	0.003	0.004	0.009
0.16	0.004	0.006	0.009
0.31	0.007	0.011	0.007
0.63	0.009	0.021	0.005
1.25	0.039	0.021	0.035
2.50	0.065	0.052	0.058
5.00	0.105	0.112	0.098
10.00	0.264	0.261	0.221

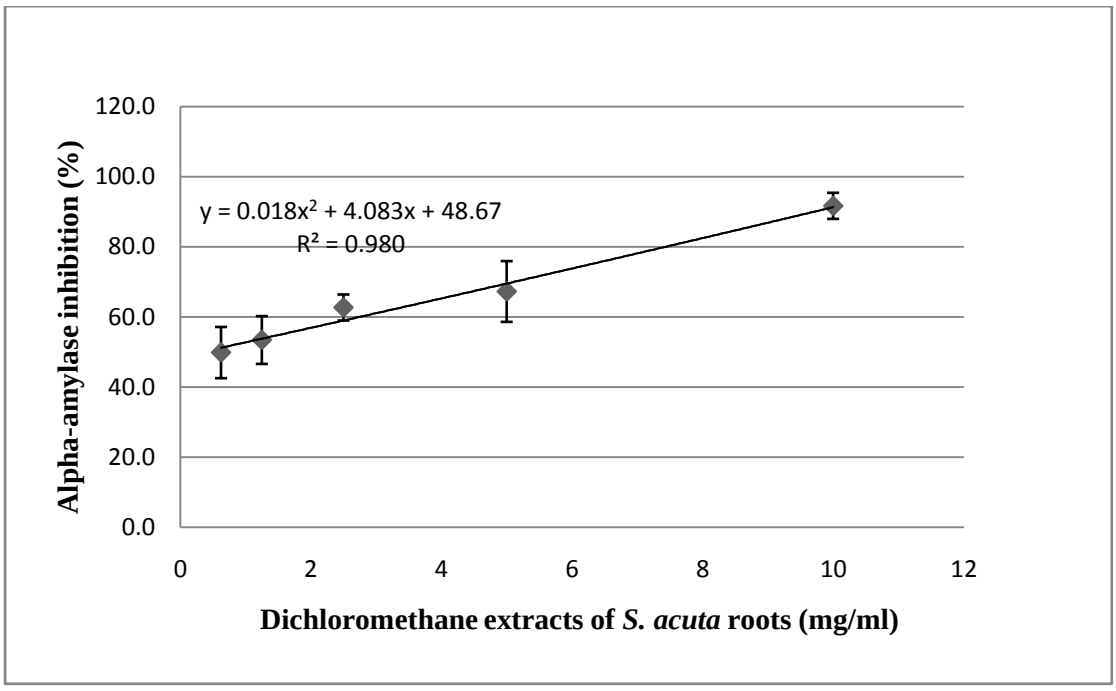


Figure 43 Alpha-amylase inhibition of dichloromethane extracts of *S. acuta* roots

Table 53 Alpha-amylase inhibition of methanolic extracts of *S. acuta* roots

Methanolic extracts of *S. acuta* roots (mg/ml)	OD_{405} (reaction mixture)			Alpha-amylase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.774	0.788	0.722					
0.02	0.712	0.698	0.712	2.0	0.0	1.0	1.0	1.0
0.04	0.687	0.652	0.691	7.4	7.9	4.9	6.7	1.6
0.08	0.611	0.635	0.599	19.4	11.7	19.7	16.9	4.5
0.16	0.532	0.531	0.542	31.4	28.8	29.1	29.8	1.4
0.31	0.521	0.498	0.499	34.1	35.3	36.9	35.4	1.4
0.63	0.412	0.402	0.434	51.9	52.3	47.2	50.5	2.8
1.25	0.408	0.423	0.384	57.1	47.0	58.1	54.1	6.2
2.50	0.375	0.419	0.443	69.2	61.5	51.6	60.8	8.8
5.00	0.399	0.438	0.445	81.5	75.5	74.6	77.2	3.7
10.00	0.726	0.676	0.627	96.6	90.2	100.4	95.7	5.2

Methanolic extracts of *S. acuta* roots (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.067	0.118	0.025
0.02	0.019	0.028	0.022
0.04	0.032	0.034	0.028
0.08	0.041	0.042	0.039
0.16	0.047	0.051	0.048
0.31	0.055	0.061	0.059
0.63	0.072	0.077	0.066
1.25	0.105	0.063	0.092
2.50	0.157	0.155	0.106
5.00	0.268	0.266	0.268
10.00	0.702	0.601	0.63

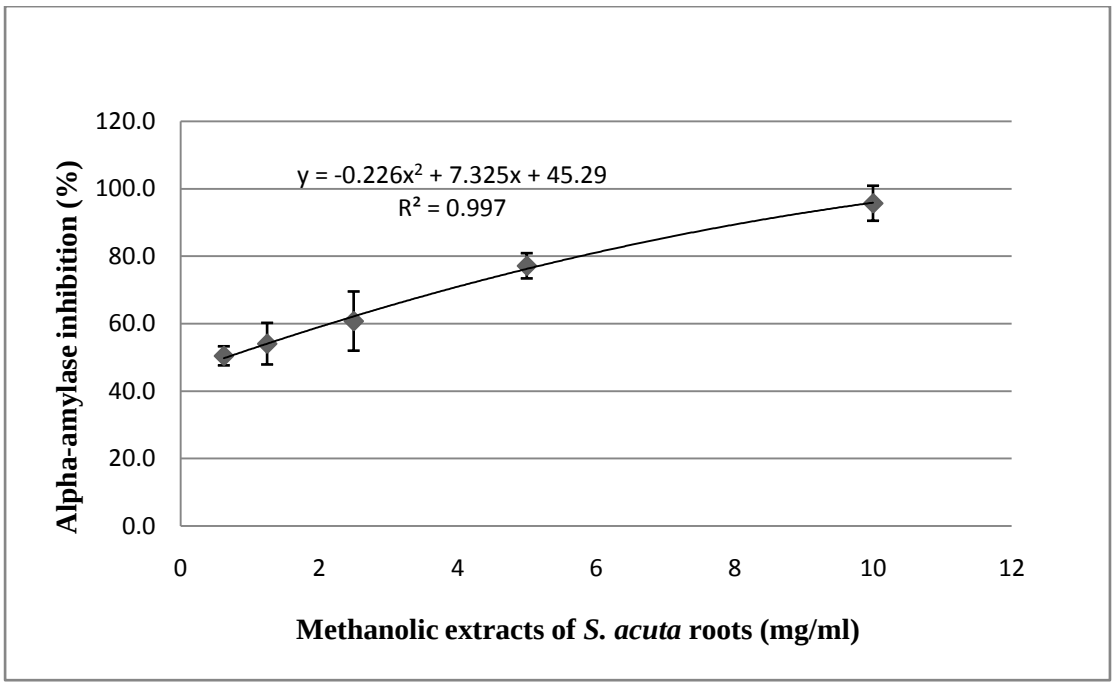


Figure 44 Alpha-amylase inhibition of methanolic extracts of *S. acuta* roots

Table 54 Alpha-amylase inhibition of dichloromethane extracts of *S. acuta* stems

Dichloromethane extracts of *S. acuta* stems (mg/ml)	OD_{405} (reaction mixture)			Alpha-amylase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.523	0.501	0.521					
0.02	0.691	0.711	0.723	-8.8	-6.8	-7.6	-7.7	1.0
0.04	0.638	0.673	0.699	6.2	8.3	4.9	6.5	1.7
0.08	0.632	0.688	0.672	18.7	14.3	12.3	15.1	3.2
0.16	0.738	0.742	0.721	21.7	17.5	22.2	20.5	2.6
0.31	0.708	0.792	0.843	36.4	37.2	29.4	34.3	4.3
0.63	0.792	0.811	0.817	44.5	40.8	36.1	40.5	4.2
1.25	1.022	1.138	1.125	45.9	46.8	36.1	40.5	4.2
2.50	1.186	1.229	1.188	57.6	52.1	59.5	47.2	1.5
5.00	1.783	1.702	1.709	68.0	71.2	68.8	69.3	1.7
10.00	1.861	1.857	1.867	83.2	84.6	83.0	83.6	0.9

Dichloromethane extracts of *S. acuta* stems (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.089	0.055	0.034
0.02	0.219	0.211	0.199
0.04	0.231	0.244	0.236
0.08	0.279	0.287	0.245
0.16	0.398	0.356	0.342
0.31	0.432	0.498	0.499
0.63	0.551	0.534	0.506
1.25	0.787	0.889	0.876
2.50	1.002	1.005	0.991
5.00	1.644	1.567	1.557
10.00	1.788	1.785	1.784

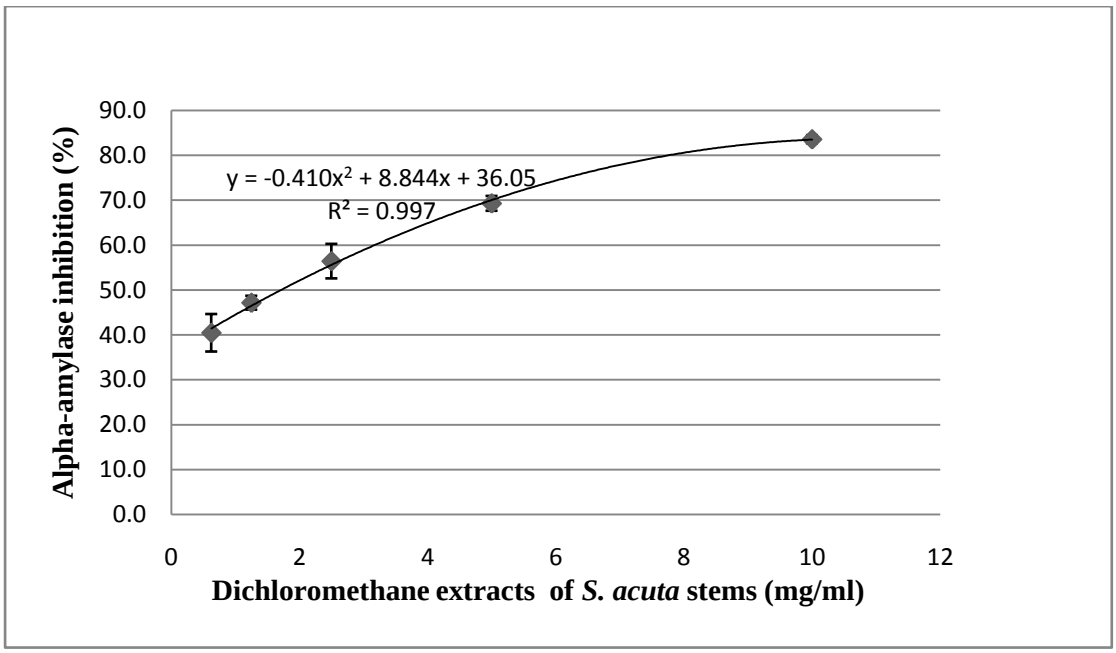


Figure 45 Alpha-amylase inhibition of dichloromethane extracts of *S. acuta* stems

Table 55 Alpha-amylase inhibition of methanolic extracts of *S. acuta* stems

Methanolic extracts of *S. acuta* stems (mg/ml)	OD_{405} (reaction mixture)			Alpha-amylase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	0.523	0.501	0.521					
0.6	0.423	0.464	0.445	28.3	27.6	30.8	28.9	1.7
1.3	0.476	0.488	0.498	35.9	37.9	38.6	37.5	1.4
2.5	0.435	0.457	0.463	50.7	49.8	48.9	49.8	0.9
5.0	0.451	0.466	0.489	69.1	65.2	65.9	66.8	2.1
10.0	0.51	0.412	0.395	87.3	84.5	85.4	85.8	1.4

Methanolic extracts of *S. acuta* stems (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.089	0.055	0.034
0.6	0.112	0.141	0.108
1.3	0.198	0.211	0.199
2.5	0.221	0.233	0.214
5.0	0.317	0.311	0.323
10.0	0.455	0.343	0.324

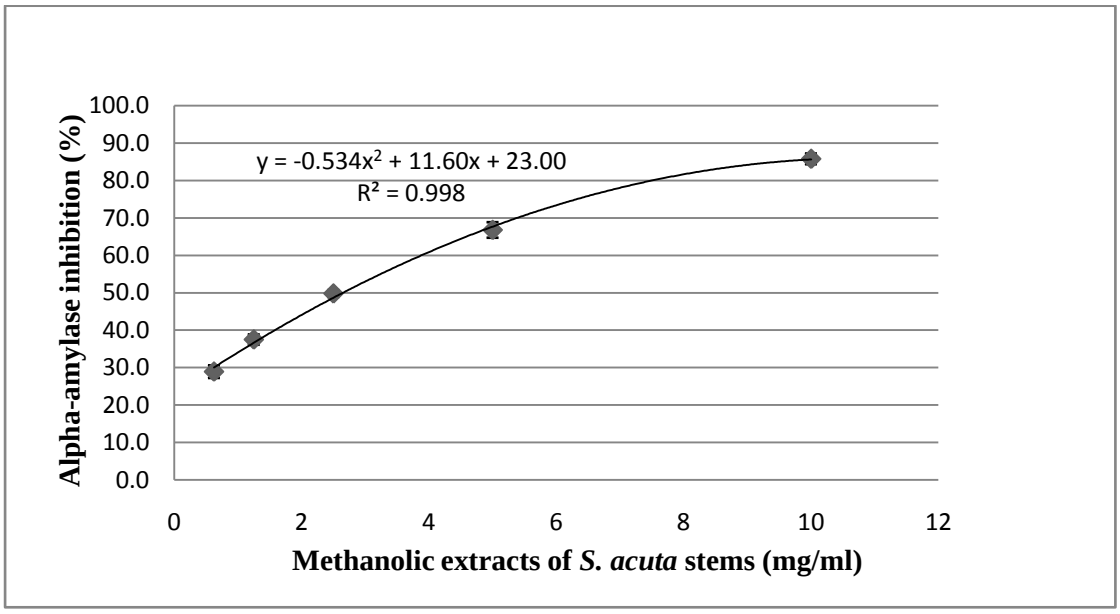


Figure 46 Alpha-amylase inhibition of methanolic extracts of *S. acuta* stems

Table 56 Alpha-amylase inhibition of dichloromethane extracts of *M. coromandelianum* leaves

Dichloromethane extracts of *M. coromandelianum* leaves (mg/ml)	OD_{405} (reaction mixture)			Alpha-amylase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.504	0.493	0.571					
0.02	0.444	0.467	0.543	2.7	1.1	6.3	3.4	2.7
0.04	0.432	0.434	0.522	8.3	15.8	16.5	13.5	4.6
0.08	0.441	0.442	0.511	17.7	20.3	23.4	20.5	2.8
0.16	0.442	0.429	0.487	21.8	26.9	29.3	26.0	3.8
0.31	0.398	0.387	0.439	30.0	37.4	41.0	36.3	5.4
0.63	0.361	0.342	0.482	43.2	50.5	40.6	44.8	5.1
1.25	0.489	0.544	0.492	65.0	58.4	49.4	57.6	7.9
2.50	0.685	0.612	0.737	82.8	66.0	77.0	75.2	8.5
5.00	0.901	1.124	0.981	92.5	96.8	85.0	91.4	6.0
10.00	1.108	1.177	1.178	107.3	95.2	86.6	96.4	10.4

Dichloromethane extracts of *M. coromandelianum* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.092	0.055	0.032
0.02	0.043	0.034	0.038
0.04	0.054	0.065	0.072
0.08	0.102	0.093	0.098
0.16	0.12	0.109	0.106
0.31	0.111	0.113	0.121
0.63	0.127	0.125	0.162
1.25	0.345	0.362	0.219
2.50	0.614	0.463	0.613
5.00	0.87	1.11	0.9
10.00	1.138	1.156	1.106

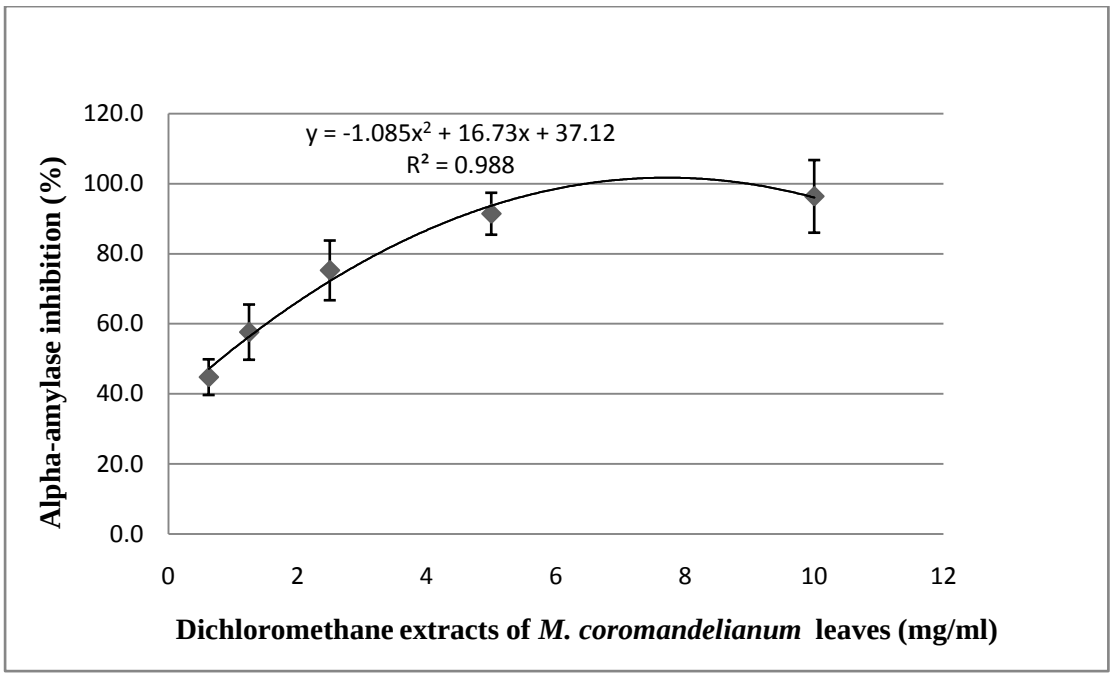


Figure 47 Alpha-amylase inhibition of dichloromethane extracts of *M. coromandelianum* leaves

Table 57 Alpha-amylase inhibition of methanolic extracts of *M. coromandelianum* leaves

Methanolic extracts of *M. coromandelianum* leaves (mg/ml)	OD_{405} (reaction mixture)			Alpha-amylase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	0.523	0.501	0.521					
0.6	0.351	0.348	0.379	36.9	37.0	38.2	37.4	0.7
1.3	0.639	0.745	0.611	48.4	45.5	46.2	46.7	1.5
2.5	0.885	0.998	0.987	58.3	54.0	59.1	57.2	2.7
5.0	1.213	1.188	1.122	76.7	79.8	74.7	77.1	2.6
10.0	2.285	2.245	2.351	90.3	95.5	98.8	94.9	4.3

Methanolic extracts of *M. coromandelianum* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.089	0.055	0.034
0.6	0.077	0.067	0.078
1.3	0.415	0.502	0.349
2.5	0.704	0.793	0.788
5.0	1.112	1.098	0.999
10.0	2.243	2.225	2.345

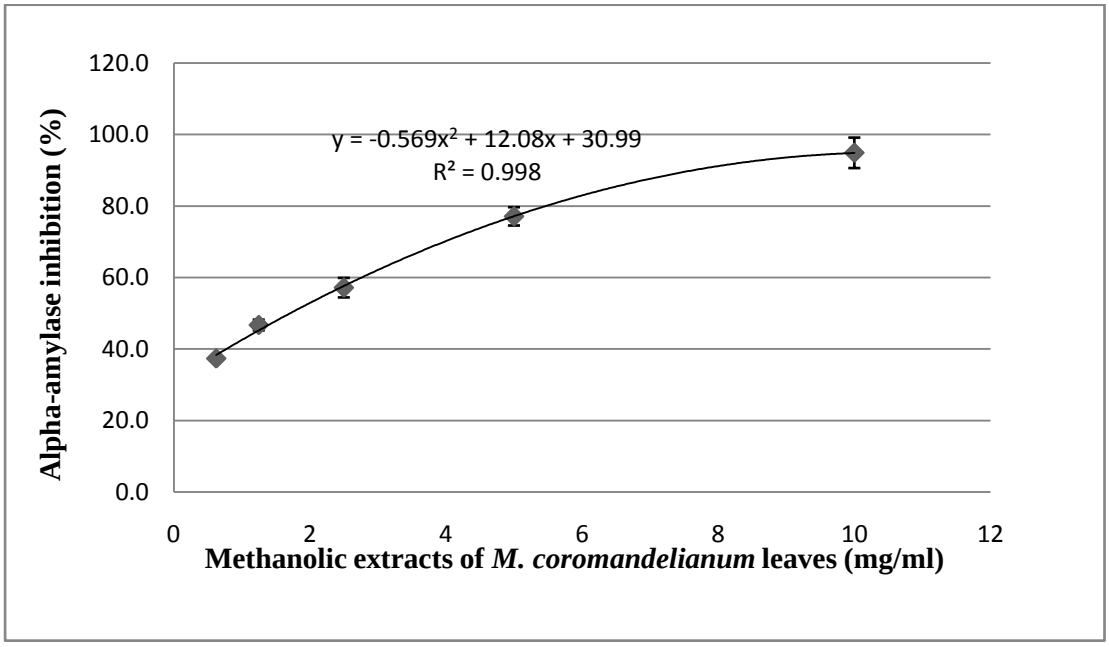


Figure 48 Alpha-amylase inhibition of methanolic extracts of *M. coromandelianum* leaves

Table 58 Alpha-amylase inhibition of dichloromethane extracts of *M. coromandelianum* roots

Dichloromethane extracts of *M. coromandelianum* roots (mg/ml)	OD_{405} (reaction mixture)			Alpha-amylase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.504	0.493	0.571					
0.02	0.322	0.358	0.41	30.1	28.8	29.3	29.4	0.7
0.04	0.296	0.319	0.369	41.5	37.9	42.3	40.6	2.3
0.08	0.287	0.286	0.352	54.1	54.1	52.3	53.5	1.0
0.16	0.234	0.248	0.274	70.4	73.3	73.1	72.3	1.6
0.31	0.216	0.212	0.231	84.5	84.5	85.9	84.9	0.8

Dichloromethane extracts of *M. coromandelianum* roots (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.092	0.055	0.032
0.02	0.034	0.046	0.029
0.04	0.055	0.047	0.058
0.08	0.098	0.085	0.095
0.16	0.112	0.131	0.129
0.31	0.152	0.144	0.155

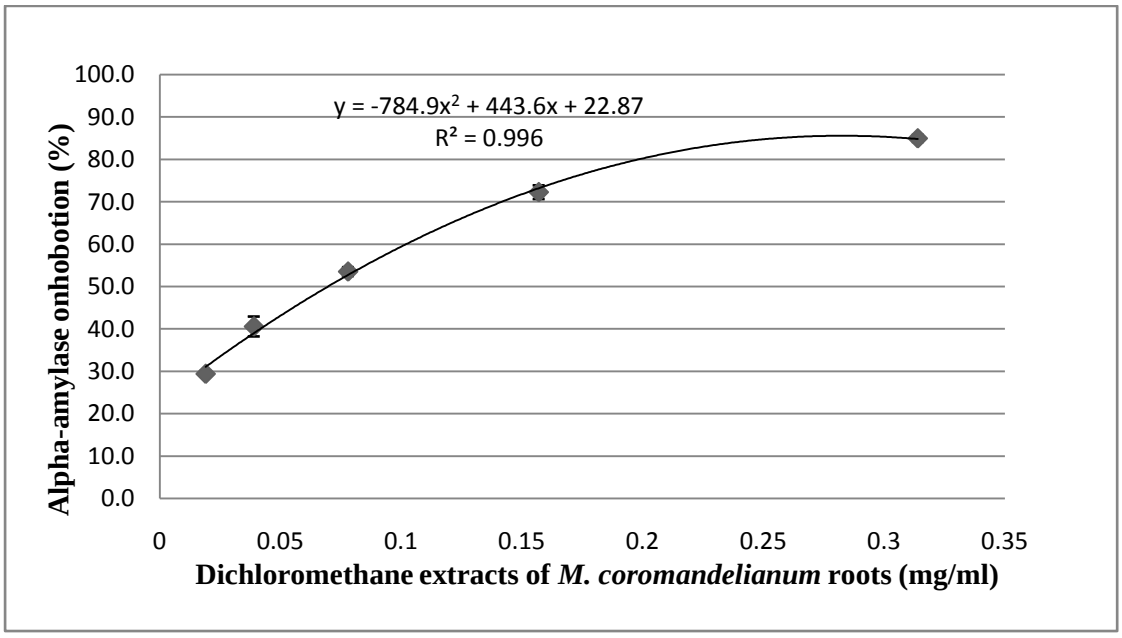


Figure 49 Alpha-amylase inhibition of dichloromethane extracts of *M. coromandelianum* roots

Table 59 Alpha-amylase inhibition of methanolic extracts of *M. coromandeliamnum* roots

Methanolic extracts of *M. coromandelianum* roots (mg/ml)	OD_{405} (reaction mixture)			Alpha-amylase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.504	0.493	0.571					
0.08	0.352	0.388	0.452	37.6	33.3	34.3	35.1	2.2
0.16	0.342	0.351	0.451	44.2	45.2	38.4	42.6	3.7
0.31	0.322	0.345	0.365	51.5	48.9	56.8	52.4	4.0
0.63	0.355	0.378	0.391	67.5	71.5	72.9	70.6	2.8
1.25	0.389	0.377	0.356	96.8	95.2	93.7	95.2	1.6

Methanolic extracts of *M. coromandelianum* roots (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.092	0.055	0.032
0.08	0.095	0.096	0.098
0.16	0.112	0.111	0.119
0.31	0.122	0.121	0.132
0.63	0.221	0.253	0.245
1.25	0.376	0.356	0.322

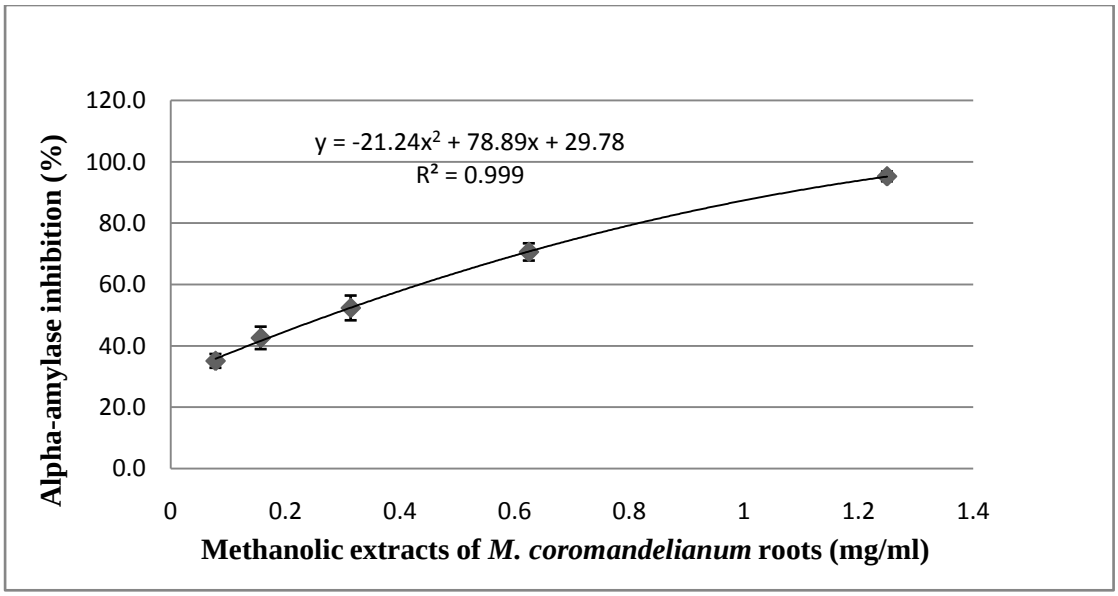


Figure 50 Alpha-amylase inhibition of methanolic extracts of *M. coromandelianum* roots

Table 60 Alpha-amylase inhibition of dichloromethane of *M. coromandelianum* stems

Dichloromethane extracts of *M. coromandelianum* stems (mg/ml)	OD_{405} (reaction mixture)			Alpha-amylase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	0.504	0.493	0.571					
0.6	0.505	0.412	0.498	34.0	34.2	30.2	32.8	2.2
1.3	0.584	0.579	0.631	44.4	41.6	42.7	42.9	1.4
2.5	0.649	0.632	0.677	57.0	52.1	50.8	53.3	3.3
5.0	0.792	0.733	0.831	73.8	71.9	72.7	72.8	0.9
10.0	1.031	1.053	1.048	88.3	88.1	88.9	88.4	0.4

Dichloromethane extracts of *M. coromandelianum* stems (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.092	0.055	0.032
0.6	0.233	0.124	0.122
1.3	0.355	0.323	0.322
2.5	0.472	0.422	0.412
5.0	0.684	0.61	0.684
10.0	0.983	1.001	0.988

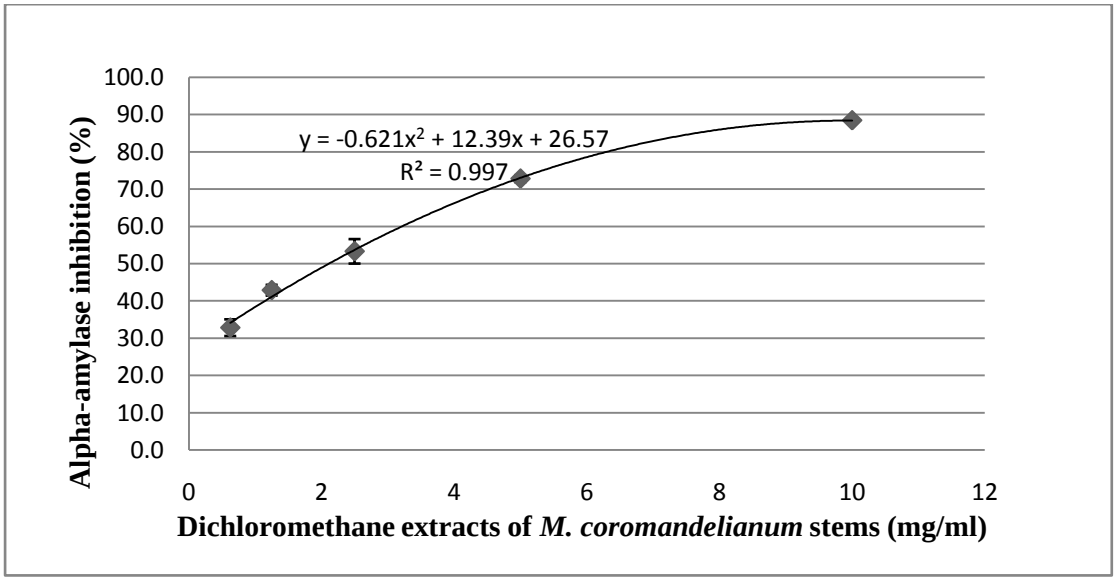


Figure 51 Alpha-amylase inhibition of dichloromethane extracts of *M. coromandelianum* stems

Table 61 Alpha-amylase inhibition of methanolic extracts of *M. coromandelianum* stems

Methanolic extracts of *M. coromandelianum* stems (mg/ml)	OD_{405} (reaction mixture)			Alpha-amylase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.504	0.493	0.571					
0.002	0.459	0.462	0.597	-11.2	-4.8	-10.6	-8.8	3.5
0.004	0.412	0.432	0.542	0.2	1.8	0.2	0.8	0.9
0.01	0.392	0.397	0.491	5.6	11.2	9.5	8.7	2.9
0.02	0.342	0.374	0.432	18.2	16.9	21.3	18.8	2.3
0.04	0.321	0.354	0.399	23.8	21.9	27.8	24.5	3.0
0.08	0.215	0.219	0.321	50.5	52.1	43.0	48.5	4.8
0.16	0.231	0.212	0.318	58.5	65.5	50.8	58.3	7.3
0.31	0.246	0.25	0.343	64.1	64.2	55.8	61.4	4.8
0.63	0.22	0.228	0.304	82.0	76.0	68.8	75.6	6.6
1.25	0.335	0.294	0.273	84.0	100.2	89.2	91.1	8.3

Methanolic extracts of *M. coromandelianum* stems (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.092	0.055	0.032
0.002	0.001	0.003	0.001
0.004	0.001	0.002	0.004
0.01	0.003	0.008	0.003
0.02	0.005	0.01	0.008
0.04	0.007	0.012	0.01
0.08	0.011	0.009	0.014
0.16	0.06	0.061	0.053
0.31	0.098	0.093	0.105
0.63	0.146	0.123	0.136
1.25	0.269	0.295	0.215

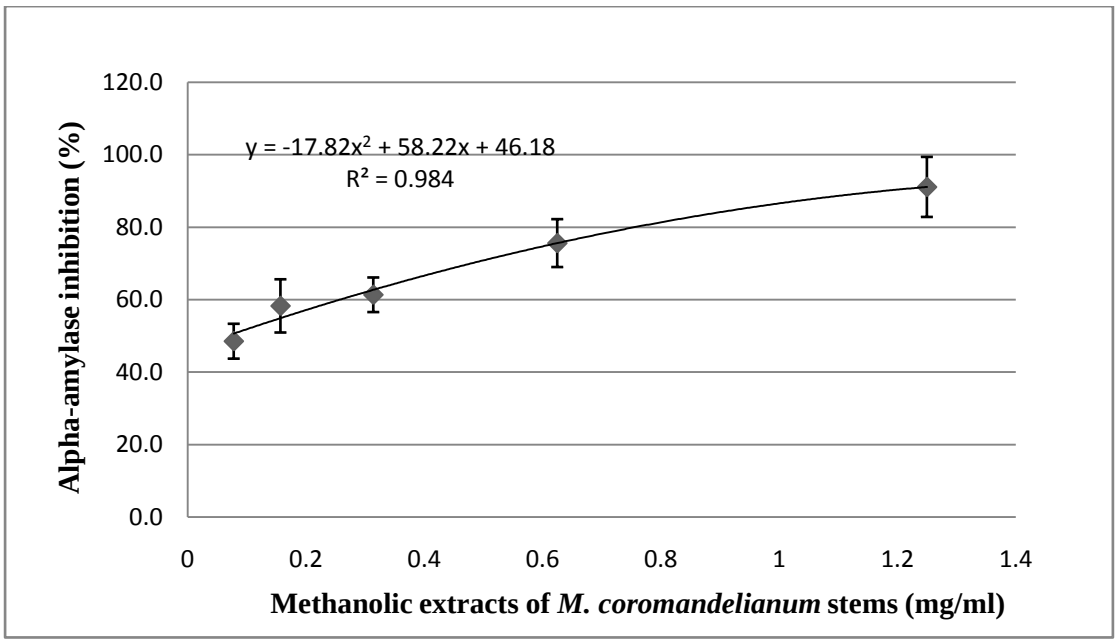


Figure 52 Alpha-amylase inhibition of methanolic extracts of *M. coromandelianum* stems

Table 62 Alpha-amylase inhibition of dichloromethane extracts of *A.indicum* leaves

Dichloromethane extracts of *A. indicum* leaves (mg/ml)	OD_{405} (reaction mixture)			Alpha-amylase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	0.523	0.501	0.521					
0.31	0.368	0.363	0.413	18.0	21.3	19.5	19.6	1.7
0.62	0.326	0.331	0.362	30.2	30.7	31.6	30.8	0.7
1.25	0.278	0.271	0.292	41.9	43.9	45.2	43.7	1.6
2.50	0.218	0.205	0.211	63.4	66.4	67.8	65.8	2.2
5.00	0.284	0.269	0.259	80.2	81.8	83.4	81.8	1.6

Dichloromethane extracts of *A. indicum* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.089	0.055	0.034
0.31	0.012	0.012	0.021
0.62	0.023	0.022	0.029
1.25	0.026	0.021	0.025
2.50	0.059	0.055	0.054
5.00	0.198	0.188	0.178

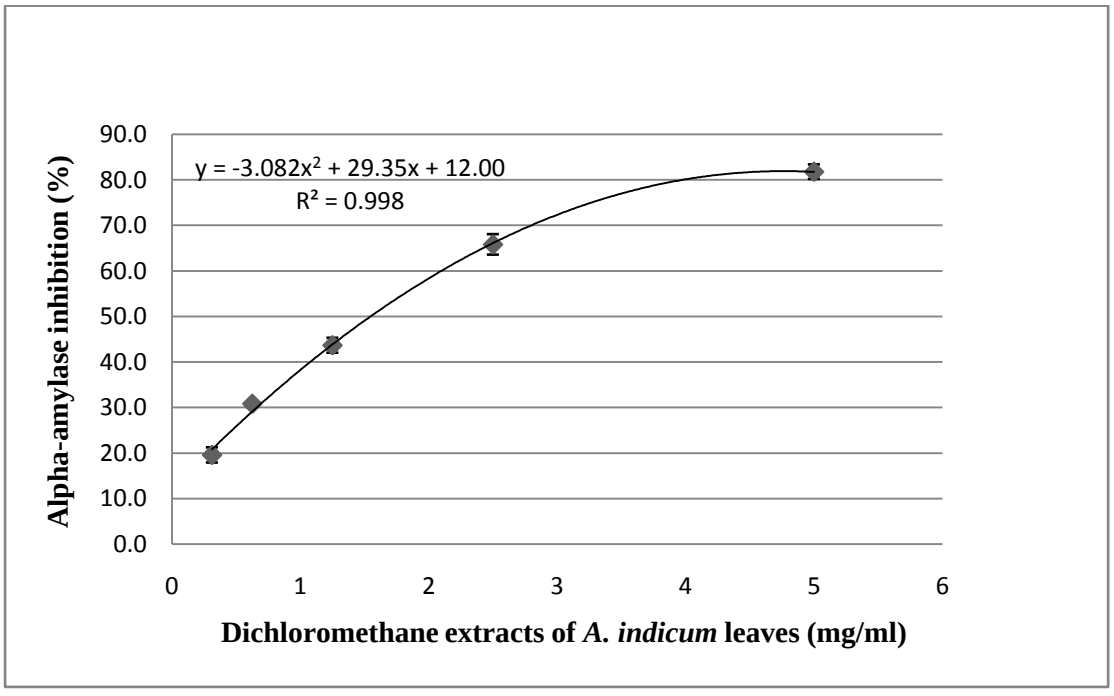


Figure 53 Alpha-amylase inhibition of dichloromethane extracts of *A. indicum* leaves

Table 63 Alpha-amylase inhibition of methanolic extracts of *A. indicum* leaves

Methanolic extracts of *A. indicum* leaves (mg/ml)	OD_{405} (reaction mixture)			Alpha-amylase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	0.504	0.493	0.571					
0.6	0.399	0.431	0.488	18.0	13.2	9.9	13.7	4.1
1.3	0.381	0.419	0.444	24.9	20.6	20.7	22.1	2.4
2.5	0.379	0.357	0.399	35.5	39.5	36.3	37.1	2.1
5.0	0.287	0.291	0.311	64.3	62.1	63.2	63.2	1.1
10.0	0.251	0.222	0.277	84.1	86.5	87.3	86.0	1.7

Methanolic extracts of *A. indicum* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.089	0.055	0.034
0.6	0.043	0.044	0.049
1.3	0.055	0.065	0.058
2.5	0.099	0.087	0.089
5.0	0.132	0.122	0.132
10.0	0.182	0.162	0.165

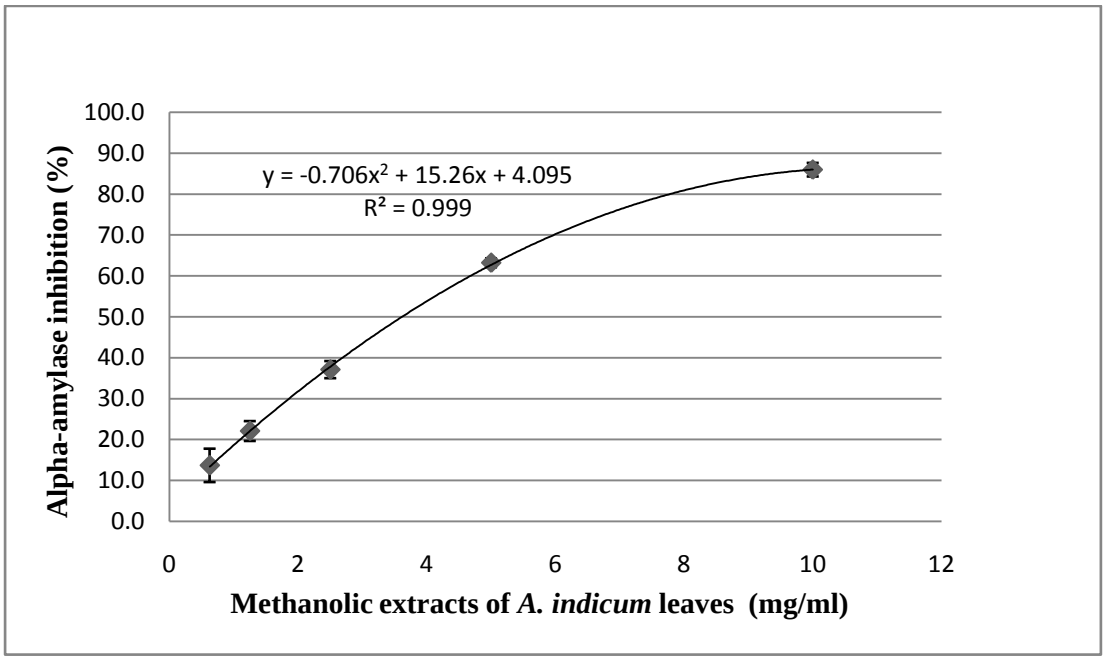


Figure 54 Alpha-amylase inhibition of methanolic extracts of *A. indicum* leaves

Table 64 Alpha-amylase inhibition of dichloromethane extracts of *A. indicum* roots

Dichloromethane extracts of *A. indicum* roots (mg/ml)	OD_{405} (reaction mixture)			Alpha-amylase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.523	0.501	0.521					
0.02	0.441	0.471	0.498	3.5	0.9	1.6	2.0	1.3
0.04	0.438	0.458	0.492	7.4	5.8	7.4	6.9	0.9
0.08	0.436	0.441	0.481	12.2	12.6	11.1	12.0	0.8
0.16	0.412	0.431	0.433	21.7	17.3	24.6	21.2	3.7
0.31	0.382	0.351	0.396	32.3	38.1	35.3	35.2	2.9
0.63	0.327	0.334	0.349	46.5	46.9	47.8	47.1	0.7
1.25	0.338	0.393	0.441	50.9	54.3	54.4	53.2	2.0
2.50	0.618	0.533	0.585	62.4	60.1	64.9	62.5	2.4
5.00	0.875	0.819	0.875	72.4	75.6	77.6	75.2	2.7
10.00	0.955	1.043	0.988	87.1	83.2	84.0	84.8	2.1

Dichloromethane extracts of *A. indicum* roots (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.089	0.055	0.034
0.02	0.022	0.029	0.019
0.04	0.036	0.038	0.041
0.08	0.055	0.051	0.048
0.16	0.072	0.062	0.066
0.31	0.088	0.075	0.081
0.63	0.095	0.097	0.095
1.25	0.125	0.189	0.219
2.50	0.455	0.355	0.414
5.00	0.755	0.71	0.766
10.00	0.899	0.968	0.91

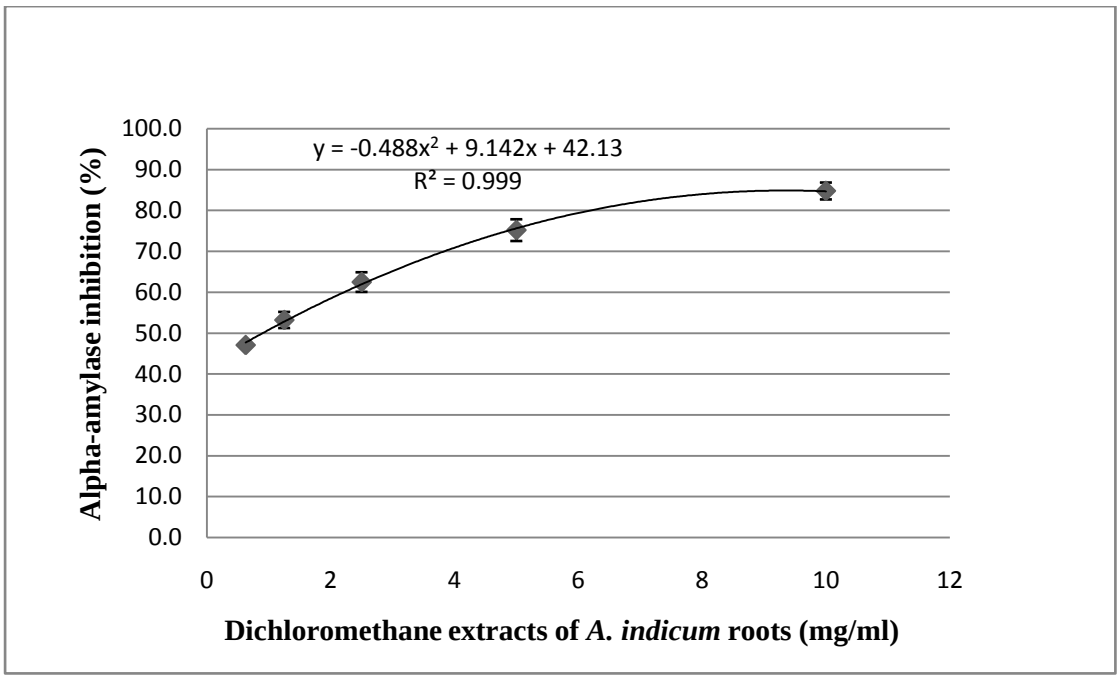


Figure 55 Alpha-amylase inhibition of dichloromethane extracts of *A. indicum* roots

Table 65 Alpha-amylase inhibition of methanolic extracts of *A. indicum* roots

Methanolic extracts of *A. indicum* roots (mg/ml)	OD_{405} (reaction mixture)			Alpha-amylase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.504	0.493	0.571					
0.02	0.404	0.422	0.511	2.2	4.8	5.8	4.2	1.8
0.04	0.379	0.412	0.492	8.7	7.3	10.0	8.7	1.4
0.08	0.352	0.377	0.449	16.7	16.7	18.2	17.2	0.9
0.16	0.332	0.337	0.411	21.8	26.7	27.3	25.3	3.0
0.31	0.302	0.331	0.389	32.0	30.1	33.0	31.7	1.5
0.63	0.258	0.316	0.325	45.6	34.9	45.3	41.9	6.1
1.25	0.256	0.312	0.354	54.4	45.9	47.1	49.1	4.6
2.50	0.4	0.408	0.403	51.0	51.4	59.2	53.8	4.6
5.00	0.355	0.421	0.454	69.4	56.8	62.5	62.9	6.3
10.00	0.413	0.519	0.514	86.4	87.2	82.4	85.3	2.6

Methanolic extracts of *A. indicum* roots (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.092	0.055	0.032
0.02	0.001	0.005	0.003
0.04	0.003	0.006	0.007
0.08	0.009	0.012	0.008
0.16	0.01	0.016	0.019
0.31	0.022	0.025	0.028
0.63	0.034	0.031	0.03
1.25	0.068	0.075	0.069
2.50	0.198	0.195	0.183
5.00	0.229	0.232	0.252
10.00	0.357	0.463	0.419

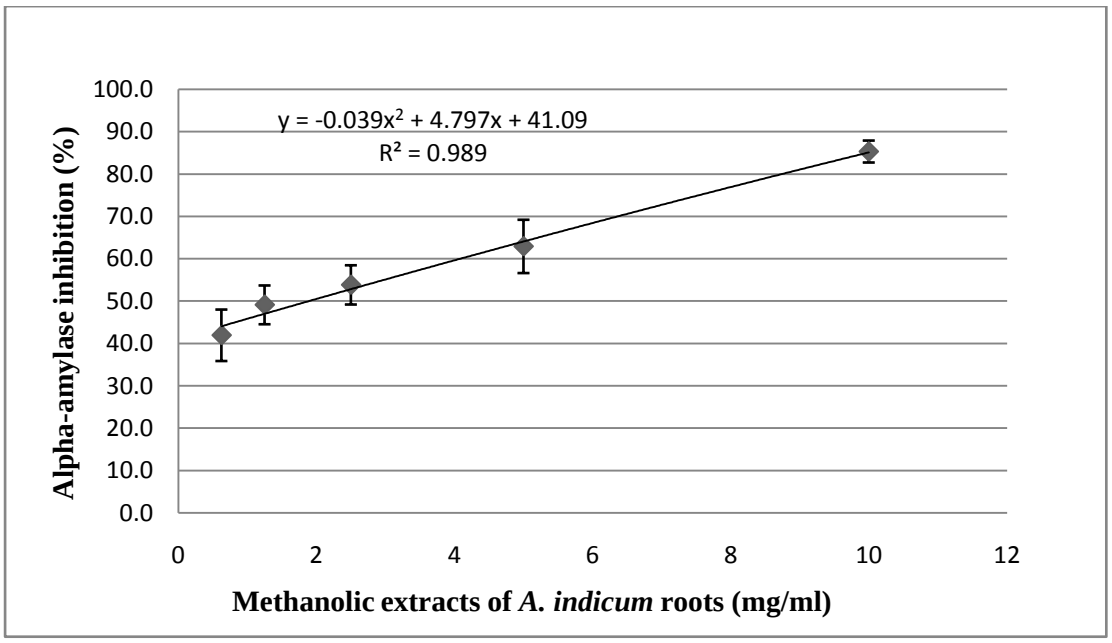


Figure 56 Alpha-amylase inhibition of methanolic extracts of *A. indicum* roots

Table 66 Alpha-amylase inhibition of dichloromethane of *A. indicum* stems

Dichloromethane extracts of *A. indicum* stems (mg/ml)	OD_{405} (reaction mixture)			Alpha-amylase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	0.523	0.501	0.521					
0.6	0.49	0.521	0.547	35.5	39.0	38.6	37.7	1.9
1.3	0.541	0.564	0.591	41.0	45.1	49.5	45.2	4.2
2.5	0.935	0.927	0.948	53.2	51.6	53.8	52.9	1.2
5.0	0.976	0.962	0.973	72.4	71.1	75.6	73.0	2.3
10.0	1.008	1.01	0.932	94.0	94.6	98.2	95.6	2.2

Dichloromethane extracts of *A. indicum* stems (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.089	0.055	0.034
0.6	0.021	0.249	0.248
1.3	0.285	0.319	0.349
2.5	0.732	0.711	0.723
5.0	0.856	0.833	0.854
10.0	0.982	0.986	0.923

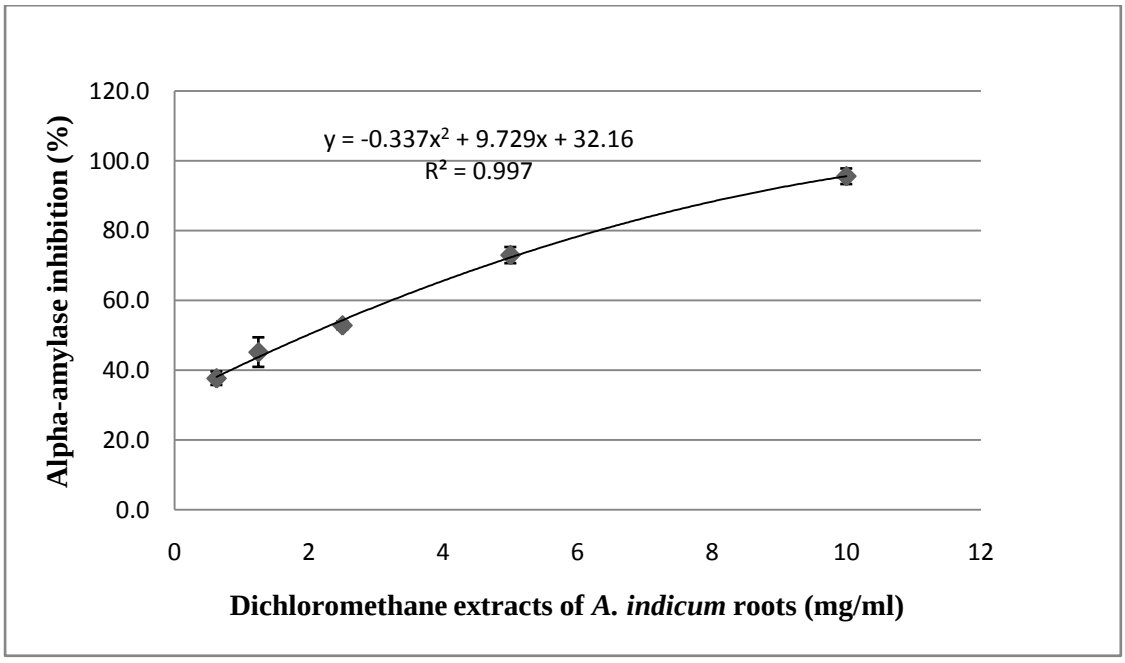


Figure 57 Alpha-amylase inhibition of dichloromethane extracts of *A. indicum* stems

Table 67 Alpha-amylase inhibition of methanolic extracts of *A. indicum* stems

Methanolic extracts of *A. indicum* stems (mg/ml)	OD_{405} (reaction mixture)			Alpha-amylase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.523	0.501	0.521					
0.02	0.433	0.463	0.522	2.3	-2.7	-6.4	-2.3	4.4
0.04	0.402	0.412	0.453	9.9	10.3	11.1	10.4	0.6
0.08	0.393	0.398	0.428	14.3	17.0	15.2	15.5	1.4
0.16	0.366	0.378	0.422	24.2	24.0	20.1	22.8	2.3
0.31	0.355	0.348	0.387	30.2	33.2	30.6	31.3	1.6
0.63	0.294	0.315	0.365	47.7	41.7	42.3	43.9	3.3
1.25	0.376	0.418	0.412	49.3	48.4	48.7	48.8	0.5
2.50	0.382	0.372	0.449	58.3	59.4	59.8	59.2	0.8
5.00	0.458	0.461	0.462	75.8	76.0	73.1	75.0	1.6
10.00	0.581	0.578	0.581	87.6	89.0	87.3	87.9	0.9

Methanolic extracts of *A. indicum* stems (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.089	0.055	0.034
0.02	0.009	0.005	0.004
0.04	0.011	0.012	0.02
0.08	0.021	0.028	0.015
0.16	0.037	0.039	0.033
0.31	0.052	0.05	0.049
0.63	0.067	0.055	0.084
1.25	0.156	0.188	0.162
2.50	0.201	0.191	0.253
5.00	0.353	0.354	0.331
10.00	0.527	0.529	0.519

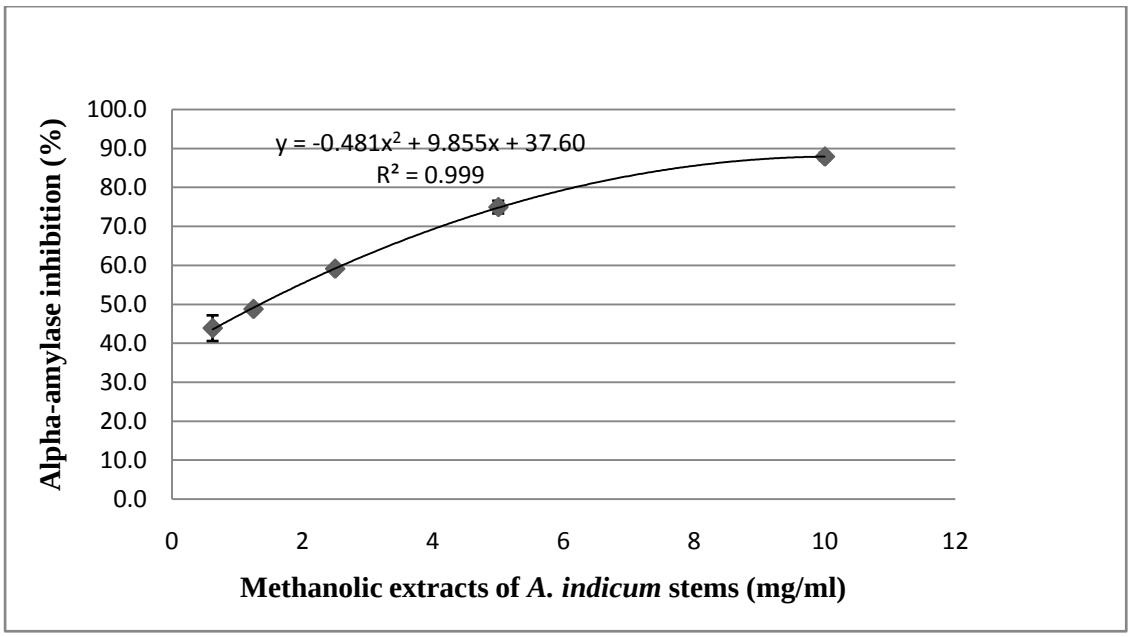


Figure 58 Alpha-amylase inhibition of methanolic extracts of *A. indicum* stems

Table 68 Alpha-amylase inhibition of acarbose

Acarbose (mg/ml)	OD_{405} (reaction mixture)			Yeast alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	0.504	0.493	0.571					
0.09	0.473	0.498	0.555	5.8	7.5	15.2	9.5	5.0
0.187	0.411	0.436	0.441	23.5	22.8	38.2	28.2	8.7
0.375	0.305	0.384	0.364	54.6	36.8	52.7	48.0	9.8
0.75	0.233	0.207	0.268	73.8	76.0	71.2	73.7	2.4
1.5	0.204	0.138	0.282	95.1	93.2	82.4	90.2	6.9

Acarbose (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.092	0.055	0.032
0.09	0.085	0.093	0.098
0.187	0.096	0.098	0.108
0.375	0.118	0.107	0.109
0.75	0.125	0.102	0.113
1.5	0.184	0.108	0.187

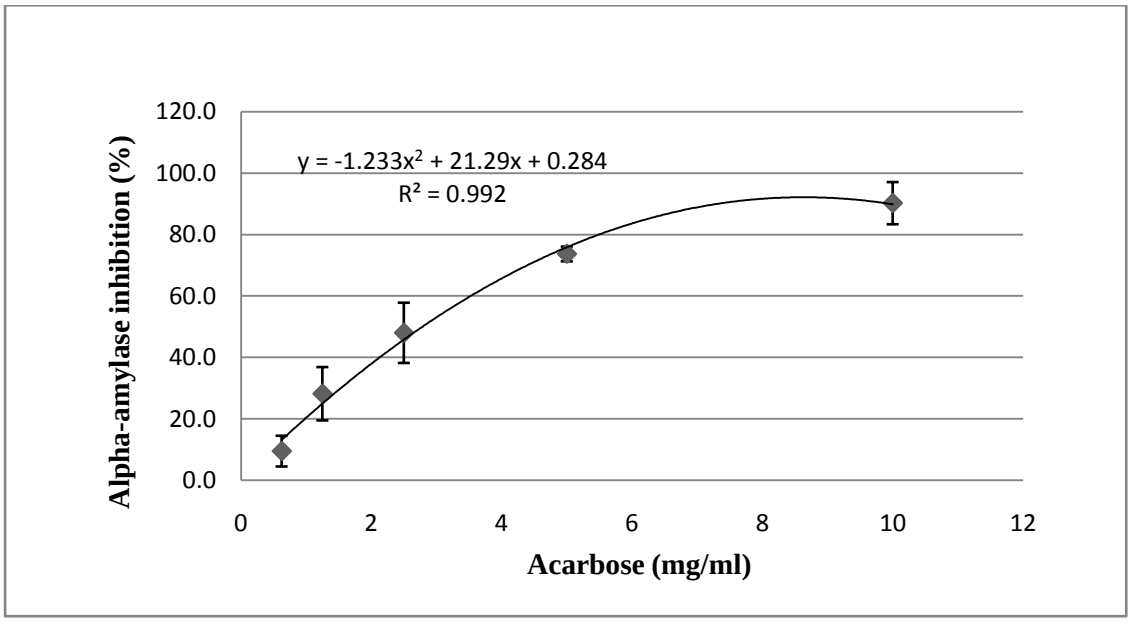


Figure 59 Alpha-amylase inhibition of Acarbose

Table 69 Rat alpha-glucosidase inhibition of dichloromethane extracts of *S. acuta* leaves

Dichloromethane extracts of *S. acuta* leaves (mg/ml)	OD_{405} (reaction mixture)			Rat alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.702	0.664	1.146					
0.02	0.735	0.675	1.223	-7.5	-12.3	-8.3	-9.4	2.6
0.04	0.65	0.623	1.079	6.7	-0.4	5.8	4.0	3.8
0.08	0.687	0.597	1.069	7.8	7.3	7.3	7.5	0.3
0.16	0.698	0.675	1.115	12.4	6.1	10.6	9.7	3.2
0.31	0.774	0.705	1.098	25.5	11.0	18.4	14.9	3.7
0.63	0.725	0.592	0.921	40.0	33.3	34.1	35.8	3.6
1.25	0.716	0.685	0.922	39.8	41.0	40.9	40.5	0.6
2.50	1.225	1.174	1.436	52.7	50.1	52.3	51.7	1.4
5.00	1.612	1.478	1.659	65.7	62.2	64.3	64.1	1.8
10.00	2.407	2.437	2.622	73.4	75.2	77.5	75.4	2.0

Dichloromethane extracts of *S. acuta* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.089	0.127	0.139
0.02	0.076	0.072	0.078
0.04	0.078	0.084	0.083
0.08	0.122	0.099	0.089
0.16	0.161	0.171	0.17
0.31	0.256	0.227	0.235
0.63	0.357	0.234	0.224
1.25	0.347	0.368	0.297
2.50	0.935	0.906	0.932
5.00	1.402	1.275	1.282
10.00	2.244	2.304	2.384

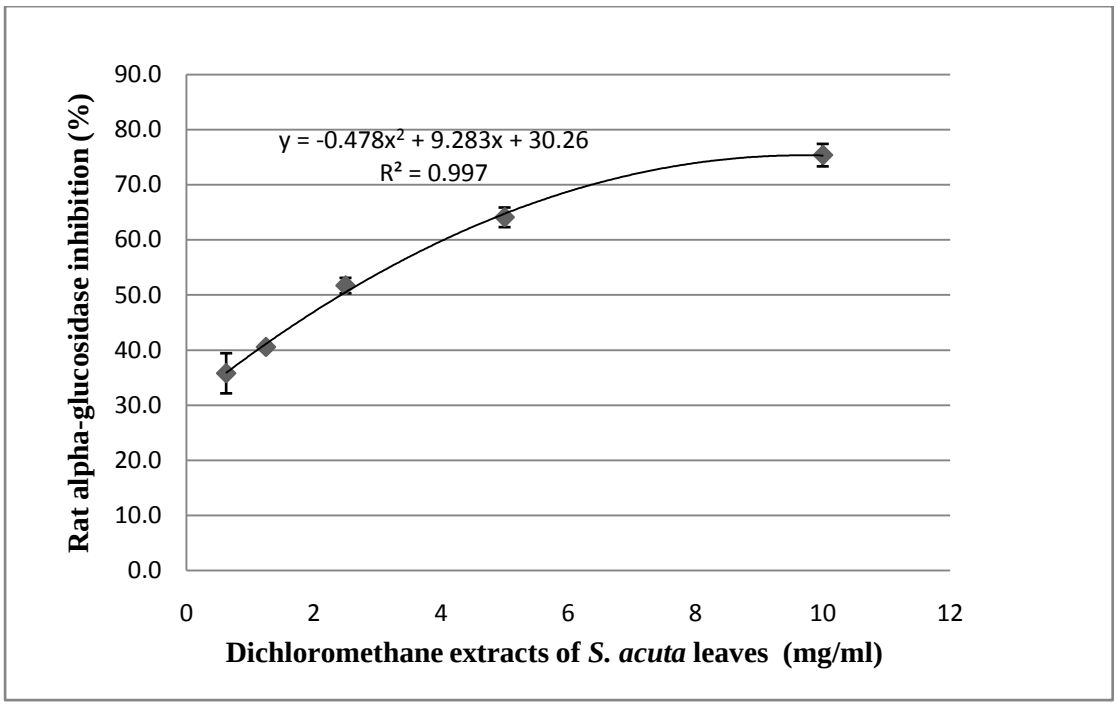


Figure 60 Rat alpha-glucosidase inhibition of dichloromethane extracts of *S. acuta* leaves

Table 70 Rat alpha-glucosidase inhibition of methanolic extracts of *S. acuta* leaves

Methanolic extracts of *S. acuta* leaves (mg/ml)	OD_{405} (reaction mixture)			Rat alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	1.49	1.038	1.035					
0.002	1.405	1.003	0.949	3.5	2.1	5.1	3.6	1.5
0.004	1.327	0.917	0.909	9.6	11.0	9.7	10.1	0.8
0.01	1.268	0.905	0.905	14.3	13.7	11.7	13.2	1.4
0.02	1.199	0.848	0.794	20.0	20.5	24.7	21.7	2.6
0.04	1.094	0.785	0.798	28.3	29.3	27.1	28.2	1.1
0.08	0.837	0.777	0.669	48.3	32.5	41.5	40.8	7.9
0.16	0.729	0.738	0.694	60.7	44.1	47.2	50.7	8.8
0.31	0.774	0.705	0.708	62.2	53.7	54.4	56.8	4.7
0.63	0.921	0.783	0.796	70.8	72.7	74.5	72.7	1.9
1.25	0.335	0.294	0.959	97.1	87.9	87.4	90.8	5.5

Methanolic extracts of *S. acuta* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.043	0.023	0.043
0.002	0.009	0.009	0.008
0.004	0.019	0.014	0.013
0.01	0.028	0.029	0.029
0.02	0.041	0.041	0.047
0.04	0.056	0.067	0.075
0.08	0.089	0.092	0.089
0.16	0.161	0.171	0.17
0.31	0.227	0.235	0.256
0.63	0.498	0.506	0.543
1.25	0.954	0.818	0.834

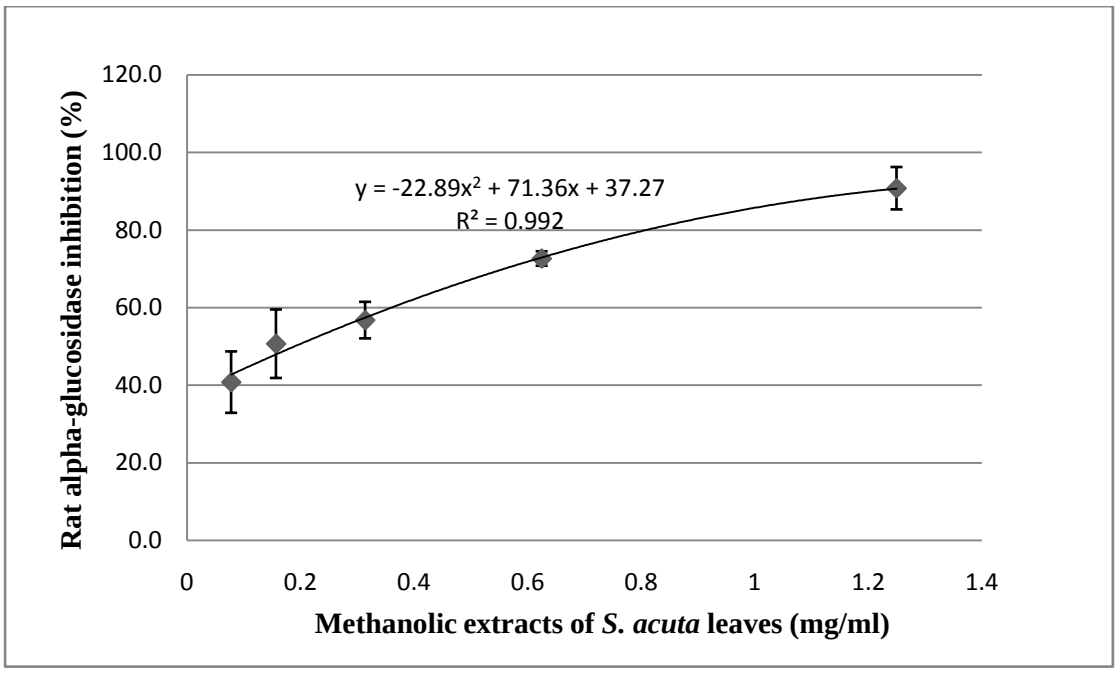


Figure 61 Rat alpha-glucosidase inhibition of methanolic extracts of *S. acuta* leaves

Table 71 Rat alpha-glucosidase inhibition of dichloromethane extracts of *S. acuta* roots

Dichloromethane extracts of *S. acuta* roots (mg/ml)	OD_{405} (reaction mixture)			Rat alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	1.49	1.038	1.035					
0.6	1.204	0.904	0.816	21.4	16.6	22.8	20.3	3.3
1.3	1.102	0.809	0.807	29.1	26.6	25.0	26.9	2.1
2.5	0.965	0.675	0.653	39.3	39.9	40.6	39.9	0.7
5.0	0.778	0.545	0.535	55.2	56.1	55.6	55.6	0.4
10.0	0.994	0.999	0.948	69.5	67.4	64.6	67.2	2.4

Dichloromethane extracts of *S. acuta* roots (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.025	0.023	0.043
0.6	0.053	0.057	0.05
1.3	0.063	0.064	0.063
2.5	0.076	0.065	0.064
5.0	0.122	0.099	0.095
10.0	0.547	0.668	0.597

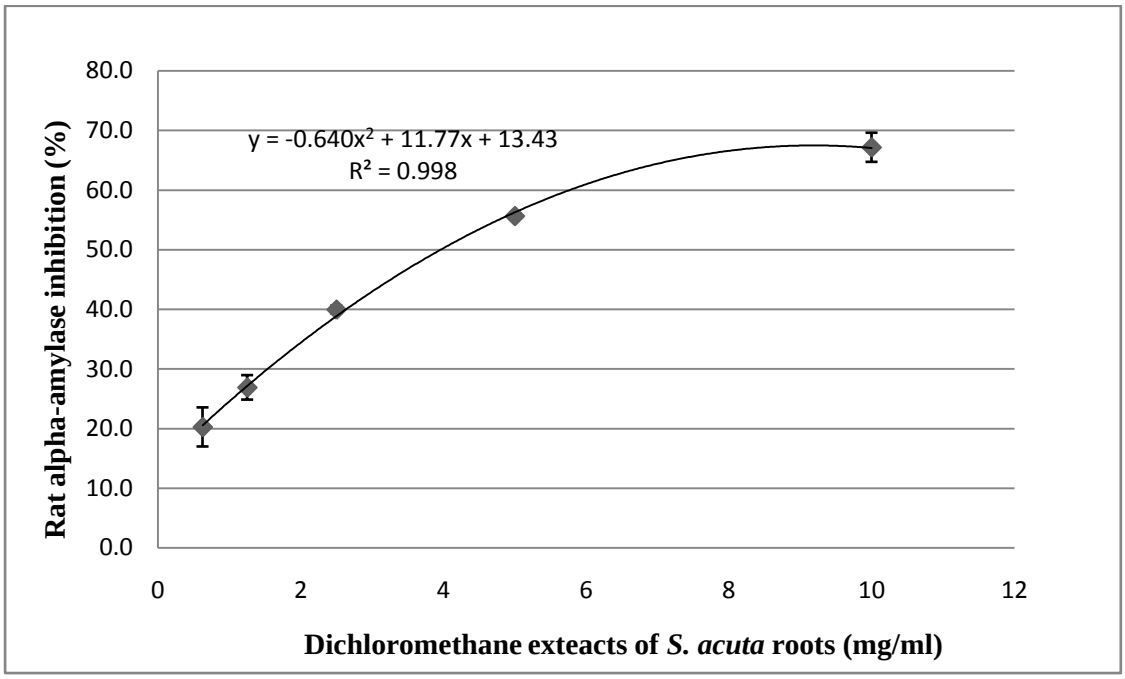


Figure 62 Rat alpha-glucosidase inhibition of dichloromethane extracts of *S. acuta* roots

Table 72 Rat alpha-glucosidase inhibition of methanolic extracts of *S. acuta* roots

Methanolic extracts of *S. acuta* roots (mg/ml)	OD_{405} (reaction mixture)			Rat alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.929	1.054	1.197					
0.04	0.802	0.827	1.103	3.6	5.7	8.7	6.0	2.5
0.08	0.769	0.81	1.112	9.5	10.1	10.0	9.9	0.3
0.16	0.732	0.771	1.009	17.5	18.0	20.5	18.7	1.6
0.31	0.639	0.678	0.908	29.4	30.7	30.7	30.3	0.7
0.63	0.646	0.639	0.815	40.6	43.5	44.0	42.7	1.8
1.25	0.612	0.703	0.856	51.8	52.6	55.0	53.1	1.7
2.50	0.735	0.769	0.761	70.8	72.1	80.2	74.4	5.1
5.00	0.935	0.911	0.907	88.7	95.1	93.6	92.5	3.4
10.00	1.468	1.181	1.138	107.6	108.3	108.4	108.1	0.4

Methanolic extracts of *S. acuta* roots (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.151	0.223	0.043
0.04	0.052	0.053	0.049
0.08	0.065	0.072	0.073
0.16	0.09	0.098	0.091
0.31	0.09	0.109	0.108
0.63	0.184	0.175	0.169
1.25	0.237	0.314	0.337
2.50	0.508	0.54	0.532
5.00	0.847	0.871	0.833
10.00	1.527	1.249	1.235

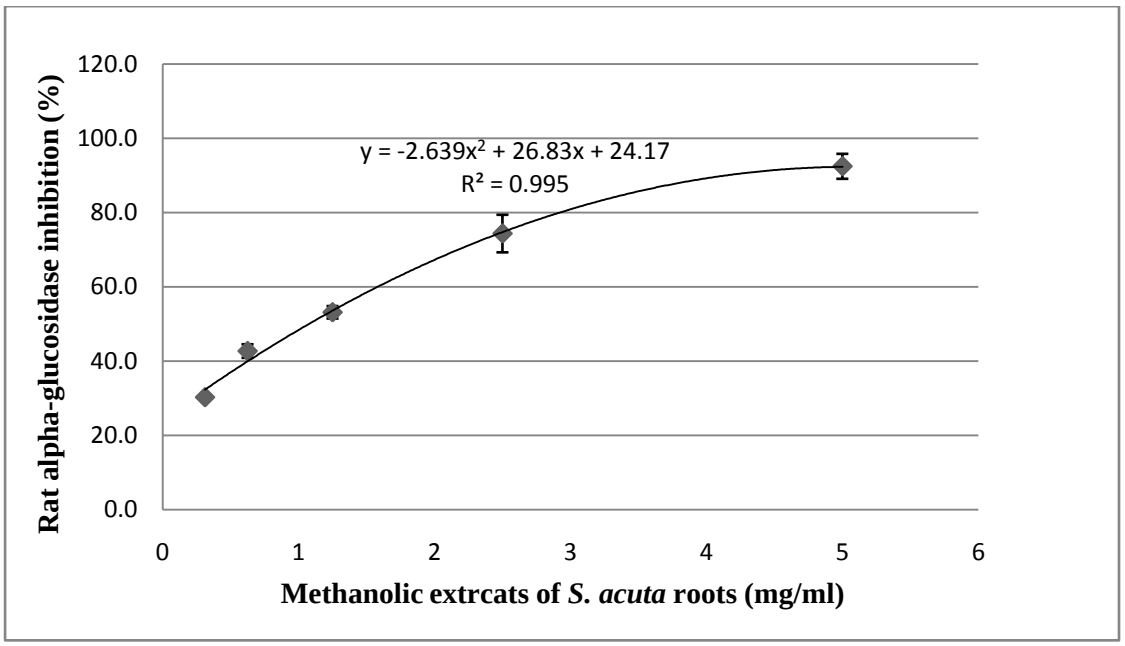


Figure 63 Rat alpha-glucosidase inhibition of methanolic extracts of S. acuta roots

Table 73 Rat alpha-glucosidase inhibition of dichloromethane extracts of *S. acuta* stems

Dichloromethane extracts of *S. acuta* stems (mg/ml)	OD_{405} (reaction mixture)			Rat alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.072	0.921	1.075					
0.02	1.002	1.009	1.122	-4.1	-11.7	-4.5	-6.7	4.3
0.04	1.009	0.991	1.102	-2.2	-7.5	-0.9	-3.5	3.5
0.08	1.002	0.919	1.098	-0.3	1.1	0.9	0.6	0.8
0.16	0.987	0.898	1.071	2.5	5.1	4.6	4.1	1.4
0.31	0.922	0.831	0.992	11.5	14.9	13.1	13.2	1.7
0.63	0.838	0.708	0.785	21.0	30.2	34.4	28.5	6.9
1.25	0.764	0.677	0.856	35.3	41.5	38.2	38.3	3.1
2.50	0.902	0.899	0.837	42.9	45.8	49.3	46.0	3.2
5.00	1.16	1.125	1.1	53.6	63.8	65.2	60.9	6.3
10.00	1.244	1.222	1.252	67.1	70.9	75.0	71.0	4.0

Dichloromethane extracts of *S. acuta* stems (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.028	0.037	0.027
0.02	0.019	0.022	0.021
0.04	0.044	0.041	0.039
0.08	0.055	0.045	0.054
0.16	0.067	0.059	0.066
0.31	0.087	0.079	0.076
0.63	0.092	0.091	0.094
1.25	0.153	0.197	0.205
2.50	0.363	0.454	0.303
5.00	0.722	0.828	0.733
10.00	0.933	0.983	0.989

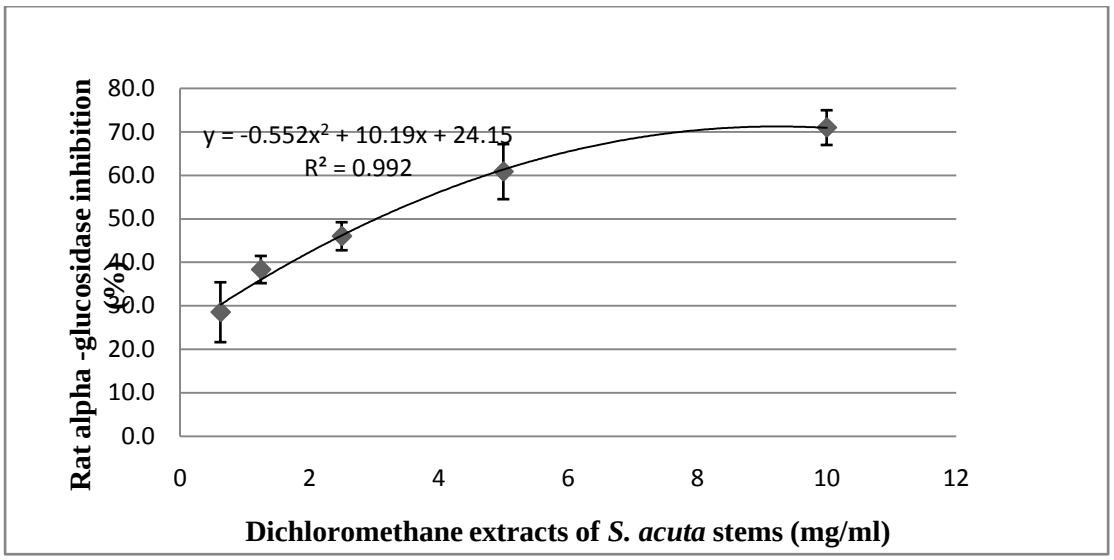


Figure 64 Rat alpha-glucosidase inhibition of dichloromethane extracts of *S. acuta* stems

Table 74 Rat alpha-amylase inhibition of methanolic extracts of *S. acuta* stems

Methanolic extracts of *S. acuta* stems (mg/ml)	OD_{405} (reaction mixture)			Rat alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.972	0.921	1.075					
0.02	1.394	1.214	1.456	-42.4	-31.8	-34.2	-36.1	5.6
0.04	1.282	1.199	1.437	-29.1	-29.5	-31.3	-30.0	1.2
0.08	1.038	1.008	1.155	-2.3	-6.0	-2.8	-3.7	2.0
0.16	1.146	1.121	1.164	-13.2	-18.6	-2.8	-11.5	8.0
0.31	1.04	1.027	1.101	-0.5	-5.0	4.9	-0.2	5.0
0.63	0.809	0.742	0.907	26.8	28.8	25.0	26.9	1.9
1.25	0.896	0.859	0.932	30.2	39.0	35.1	34.8	4.4
2.50	1.112	1.13	1.23	55.1	47.0	48.0	50.0	4.4
5.00	1.116	1.125	1.1	68.1	71.1	74.7	71.3	3.3
10.00	1.386	1.293	1.318	79.8	83.2	91.4	84.8	6.0

Methanolic extracts of *S. acuta* stems (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.028	0.037	0.027
0.02	0.05	0.049	0.042
0.04	0.063	0.054	0.053
0.08	0.072	0.071	0.072
0.16	0.077	0.073	0.08
0.31	0.091	0.099	0.099
0.63	0.118	0.113	0.117
1.25	0.237	0.358	0.248
2.50	0.688	0.695	0.682
5.00	0.815	0.888	0.833
10.00	1.195	1.155	1.227

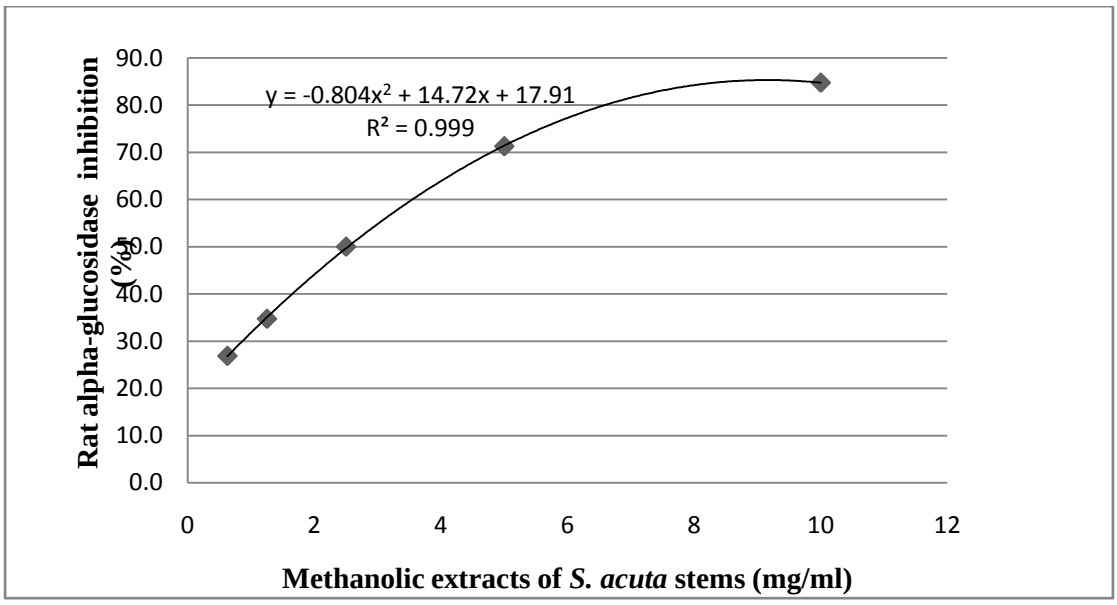


Figure 65 Rat alpha-glucosidase inhibition of methanolic extracts of *S. acuta* stems

Table 75 Rat alpha-glucosidase inhibition of dichloromethane extracts of *M. coromandelianum* leaves

Dichloromethane extracts of *M. coromandelianum* leaves (mg/ml)	OD_{405} (reaction mixture)			Rat alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	0.999	0.931	0.946					
0.6	0.809	0.802	0.907	11.2	19.4	13.7	14.8	4.2
1.3	0.786	0.899	0.902	29.4	36.7	28.5	31.6	4.5
2.5	1.112	1.13	1.23	45.5	49.1	40.1	44.9	4.5
5.0	0.966	1.325	1.22	85.0	71.8	73.8	76.8	7.1
10.0	1.704	1.649	1.602	97.7	87.8	93.6	93.0	4.9

Dichloromethane extracts of *M. coromandelianum* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.221	0.076	0.031
0.6	0.118	0.113	0.117
1.3	0.237	0.358	0.248
2.5	0.688	0.695	0.682
5.0	0.849	1.084	0.98
10.0	1.686	1.545	1.543

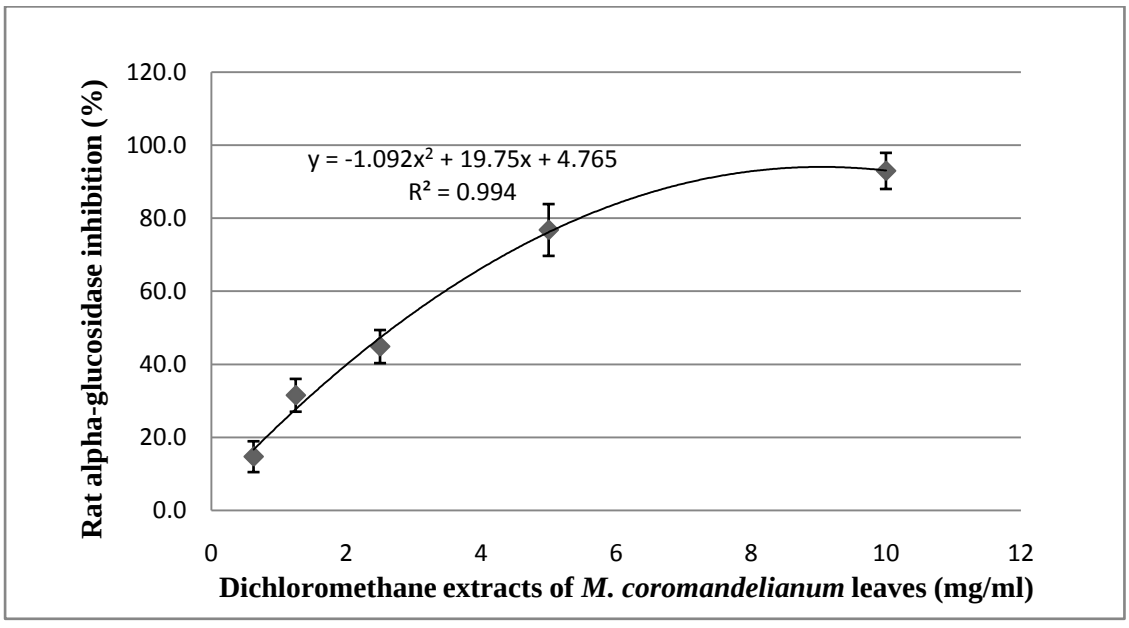


Figure 66 Rat alpha-glucosidase inhibition of dichloromethane extracts of *M. coromandelianum* leaves

Table 76 Rat alpha-glucosidase inhibition of methanolic extracts of *M. coromandelianum* leaves

Methanolic extracts of *M. coromandelianum* leaves (mg/ml)	OD_{405} (reaction mixture)			Rat alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.999	0.931	0.946					
0.02	0.918	0.992	0.992	-7.2	-5.5	0.7	-4.0	4.1
0.04	0.862	0.971	0.991	2.2	-1.8	1.7	0.7	2.2
0.08	0.808	0.922	0.987	9.8	6.2	4.6	6.9	2.7
0.16	0.807	0.891	0.941	15.6	13.8	12.3	13.9	1.6
0.31	0.835	0.899	0.892	21.9	18.5	25.6	21.9	3.6
0.63	0.795	0.842	0.865	29.9	29.1	31.5	30.2	1.2
1.25	0.842	0.84	0.879	45.8	49.2	48.6	47.9	1.9
2.50	0.998	0.958	0.969	68.3	76.6	67.1	70.7	5.2
5.00	1.316	1.491	1.326	97.3	78.0	88.6	88.0	9.7
10.00	2.156	2.02	1.923	103.0	102.9	118.5	108.1	9.0

Methanolic extracts of *M. coromandelianum* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.221	0.076	0.031
0.02	0.084	0.09	0.083
0.04	0.101	0.101	0.092
0.08	0.106	0.12	0.114
0.16	0.15	0.154	0.139
0.31	0.225	0.202	0.211
0.63	0.25	0.236	0.238
1.25	0.42	0.406	0.409
2.50	0.751	0.758	0.668
5.00	1.295	1.303	1.222
10.00	2.179	2.045	2.092

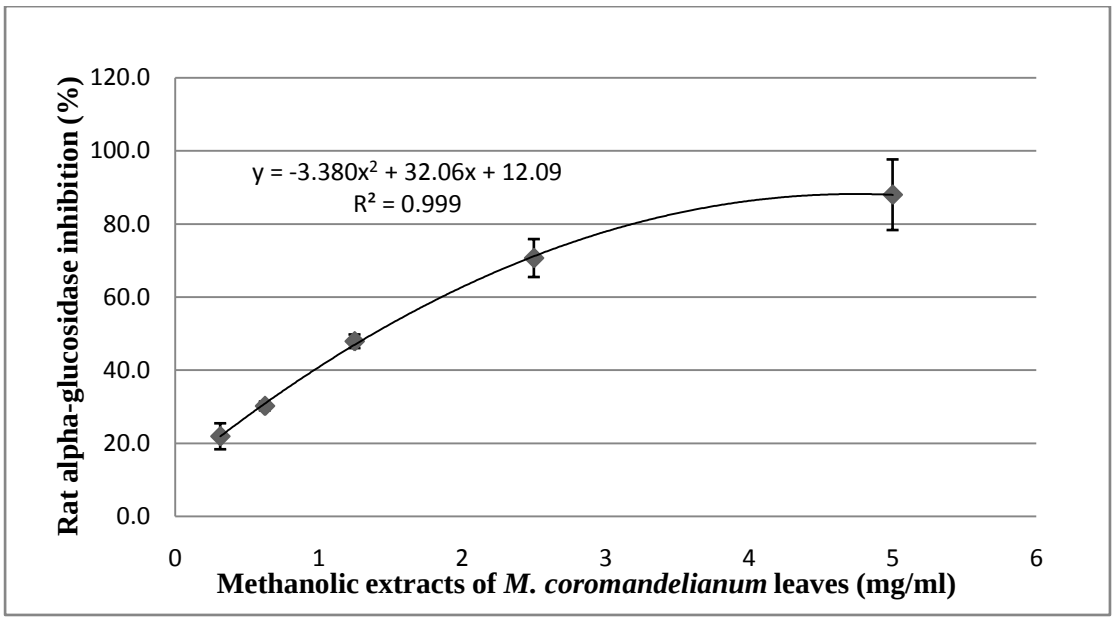


Figure 67 Rat alpha-glucosidase inhibition of methanolic extracts of *M. coromandelianum* leaves

Table 77 Rat alpha-glucosidase inhibition of dichloromethane extracts of *M. coromandelianum* roots

Dichloromethane extracts of *M. coromandelianum* roots (mg/ml)	OD_{405} (reaction mixture)			Rat alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	0.999	0.931	0.946					
0.6	0.811	0.859	0.867	10.2	12.7	17.5	13.5	3.7
1.3	0.707	0.801	0.853	23.7	19.9	19.3	21.0	2.3
2.5	0.808	0.835	0.878	42.4	45.4	39.8	42.5	2.8
5.0	0.862	0.946	0.809	66.5	62.8	73.3	67.5	5.3
10.0	1.2	1.29	1.24	84.1	74.5	82.0	80.2	5.0

Dichloromethane extracts of *M. coromandelianum* roots (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.221	0.076	0.031
0.6	0.112	0.113	0.112
1.3	0.113	0.116	0.115
2.5	0.36	0.368	0.327
5.0	0.601	0.628	0.565
10.0	1.076	1.072	1.075

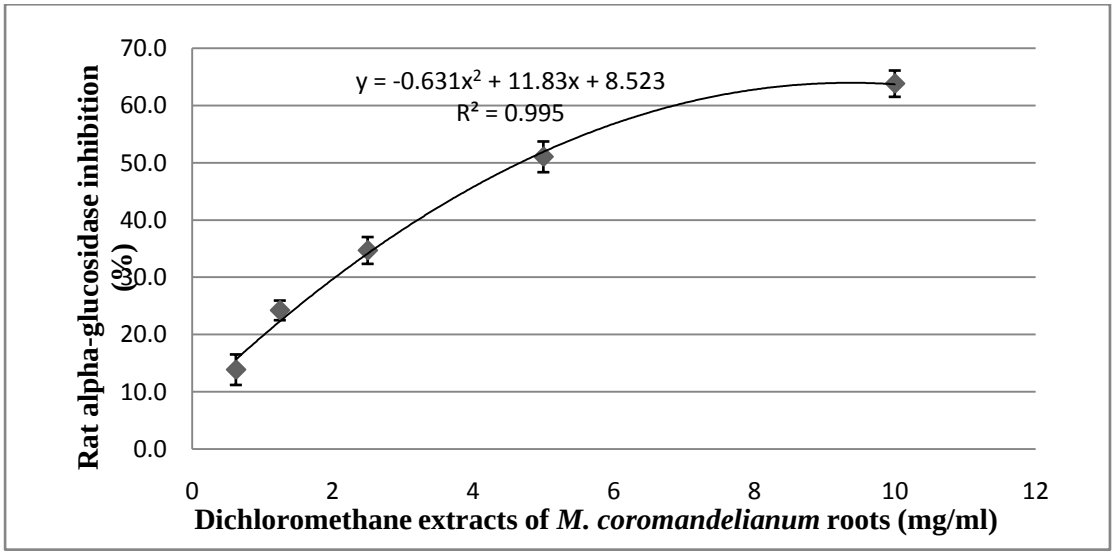


Figure 68 Rat alpha-glucosidase inhibition of dichloromethane extracts of *M. coromandelianum* roots

Table 78 Rat alpha-glucosidase inhibition of methanolic extracts of *M. coromandelianum* roots

Methanolic extracts of *M. coromandelianum* roots (mg/ml)	OD_{405} (reaction mixture)			Rat alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.999	0.931	0.946					
0.001	0.818	0.902	0.991	-5.0	-5.4	-8.1	-6.2	1.7
0.002	0.791	0.819	0.901	-1.5	4.3	1.7	1.5	2.9
0.004	0.741	0.791	0.841	5.1	7.8	8.3	7.1	1.7
0.01	0.711	0.761	0.781	9.5	11.7	15.4	12.2	3.0
0.02	0.637	0.712	0.751	19.3	17.9	18.9	18.7	0.7
0.04	0.548	0.516	0.438	31.0	41.3	53.3	41.9	11.2
0.08	0.434	0.454	0.415	45.9	48.9	56.5	50.4	5.5
0.16	0.466	0.406	0.493	58.9	69.8	61.5	63.4	5.7
0.31	0.428	0.438	0.422	79.2	78.0	81.0	79.4	1.5
0.63	0.512	0.494	0.513	80.5	100.0	100.0	93.5	11.3

Methanolic extracts of *M. coromandelianum* roots (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.221	0.076	0.031
0.001	0.001	0.001	0.002
0.002	0.001	0.001	0.002
0.004	0.003	0.003	0.002
0.01	0.007	0.006	0.007
0.02	0.009	0.01	0.009
0.04	0.011	0.014	0.011
0.08	0.013	0.017	0.017
0.16	0.146	0.148	0.141
0.31	0.266	0.25	0.248
0.63	0.36	0.494	0.513

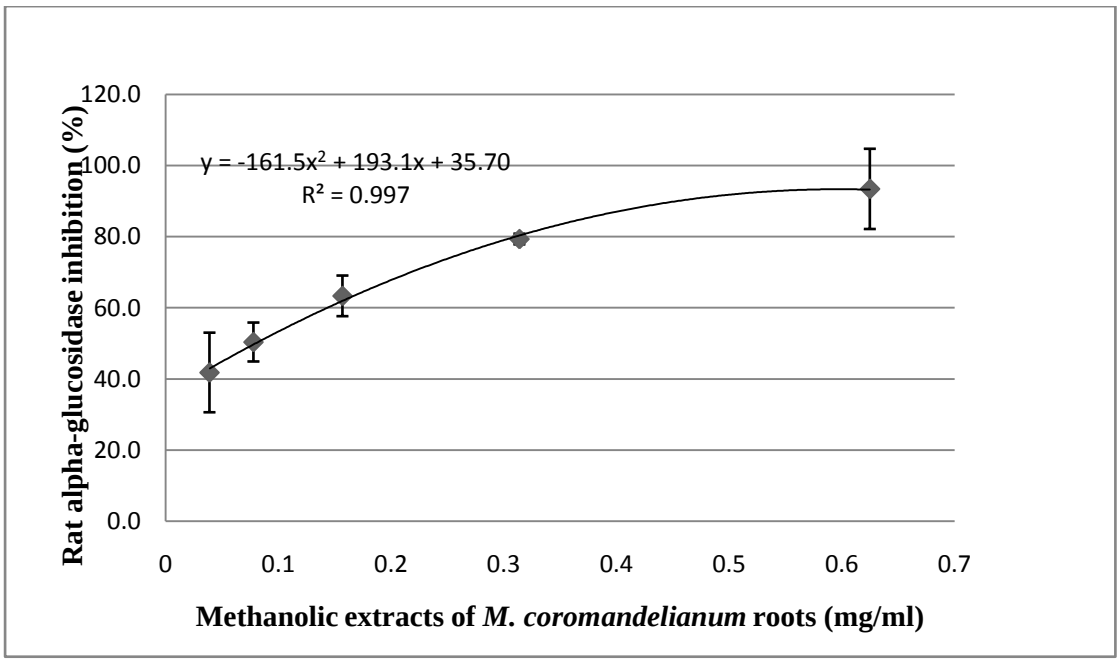


Figure 69 Rat alpha-glucosidase inhibition of methanolic extracts of *M. coromandelianum* roots

Table 79 Rat alpha-glucosidase inhibition of dichloromethane extracts of *M. coromandelianum* stems

Dichloromethane extracts of *M. coromandelianum* stems (mg/ml)	OD_{405} (reaction mixture)			Rat alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	1.072	0.921	1.075					
0.6	1.274	0.993	1.104	12.7	16.9	12.0	13.9	2.7
1.3	1.293	1.103	1.045	22.4	25.8	24.5	24.2	1.7
2.5	1.317	1.248	1.207	36.2	32.0	36.0	34.7	2.3
5.0	1.459	1.291	1.399	48.0	53.0	52.2	51.1	2.7
10.0	1.858	1.697	1.913	61.4	64.3	65.9	63.9	2.3

Dichloromethane extracts of *M. coromandelianum* stems (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.091	0.112	0.107
0.6	0.418	0.321	0.252
1.3	0.532	0.503	0.314
2.5	0.691	0.698	0.587
5.0	0.949	0.911	0.936
10.0	1.479	1.408	1.583

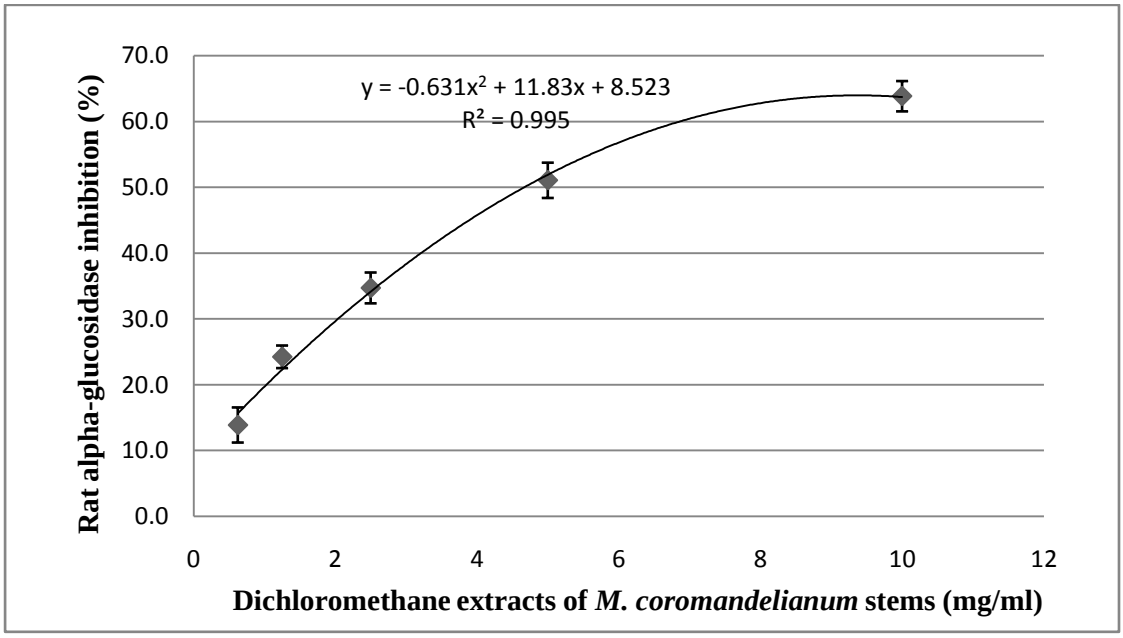


Figure 70 Rat alpha-glucosidase inhibition of dichloromethane extracts of *M coromandelianum* stems

Table 80 Rat alpha-glucosidase inhibition of methanolic extracts of *M. coromandelianum* stems

Methanolic extracts of *M. coromandelianum* leaves (mg/ml)	OD_{405} (reaction mixture)			Rat alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	1.394	1.122	1.114					
0.02	1.312	1.091	1.085	6.3	4.6	5.0	5.3	0.9
0.04	1.116	0.955	0.991	22.6	19.1	14.8	18.8	3.9
0.08	0.992	0.869	0.872	32.5	28.4	26.0	29.0	3.3
0.16	0.971	0.793	0.804	34.4	35.5	34.4	34.8	0.7
0.31	0.914	0.768	0.789	38.7	37.9	36.6	37.7	1.1
0.63	0.865	0.762	0.761	44.3	42.3	41.6	42.7	1.4
1.25	0.882	0.872	0.962	54.7	50.6	50.4	51.9	2.4
2.50	0.952	0.917	0.911	68.2	66.4	69.7	68.1	1.6
5.00	1.339	1.297	1.317	88.1	83.9	86.6	86.2	2.1
10.00	1.251	1.245	1.259	97.3	101.9	99.4	99.5	2.3

Methanolic extracts of *M. coromandelianum* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.051	0.033	0.023
0.02	0.054	0.052	0.049
0.04	0.077	0.074	0.061
0.08	0.085	0.089	0.065
0.16	0.09	0.091	0.088
0.31	0.091	0.092	0.097
0.63	0.117	0.134	0.124
1.25	0.273	0.334	0.421
2.50	0.525	0.551	0.58
5.00	1.179	1.122	1.171
10.00	1.215	1.266	1.252

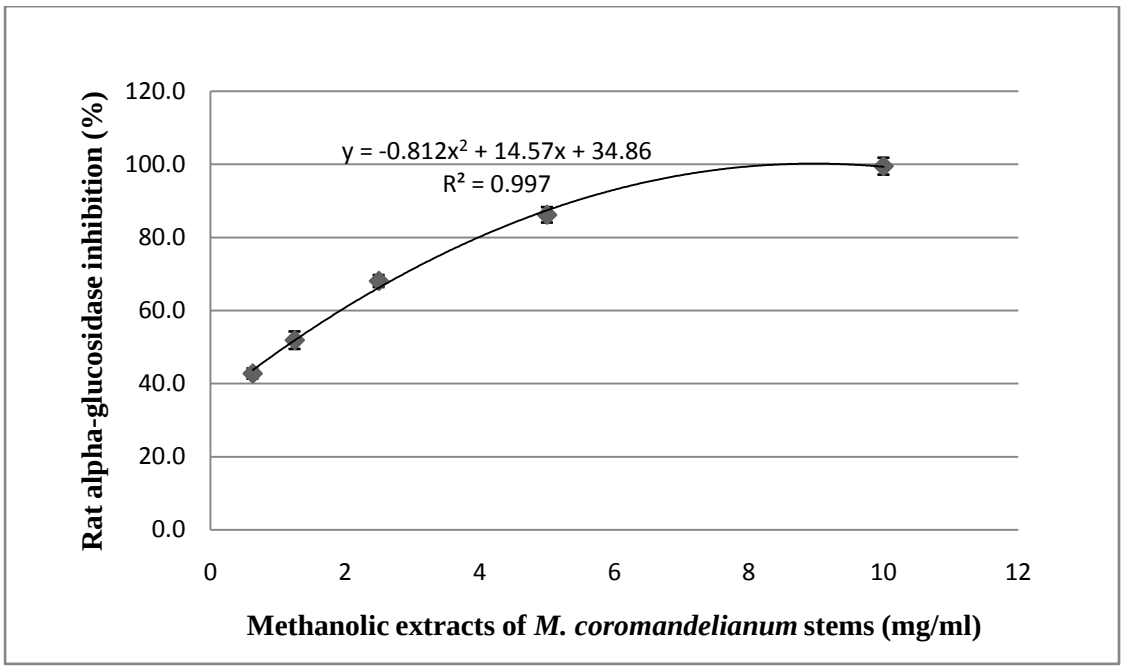


Figure 71 Rat alpha-glucosidase inhibition of methanolic extracts of *M. coromandelianum* stems

Table 81 Rat alpha-glucosidase inhibition of dichloromethane extracts of *A. indicum* leaves.

Dichloromethane extracts of *A. indicum* leaves (mg/ml)	OD_{405} (reaction mixture)			Rat alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.785	0.762	0.869					
0.04	0.822	0.732	0.892	-4.9	-5.7	-0.4	-3.7	2.9
0.08	0.788	0.696	0.892	3.1	4.8	2.8	3.6	1.1
0.16	0.699	0.633	0.828	17.1	15.6	11.9	14.9	2.7
0.31	0.642	0.583	0.829	26.7	25.3	21.8	24.6	2.5
0.63	1.766	1.793	1.719	43.3	44.3	54.5	47.4	6.2
1.25	1.871	1.834	1.832	59.5	46.5	58.0	54.7	7.1
2.50	1.911	1.92	1.902	62.8	61.9	73.9	66.2	6.7
5.00	1.964	1.981	1.968	87.4	87.7	87.7	87.6	0.2
10.00	2.086	2.264	2.153	96.9	83.3	100.0	93.4	8.9

Dichloromethane extracts of *A. indicum* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.676	0.634	0.653
0.04	0.078	0.068	0.073
0.08	0.101	0.098	0.099
0.16	0.111	0.103	0.109
0.31	0.122	0.114	0.191
0.63	1.364	1.443	1.348
1.25	1.584	1.498	1.489
2.50	1.647	1.681	1.689
5.00	1.875	1.904	1.868
10.00	2.064	2.159	2.153

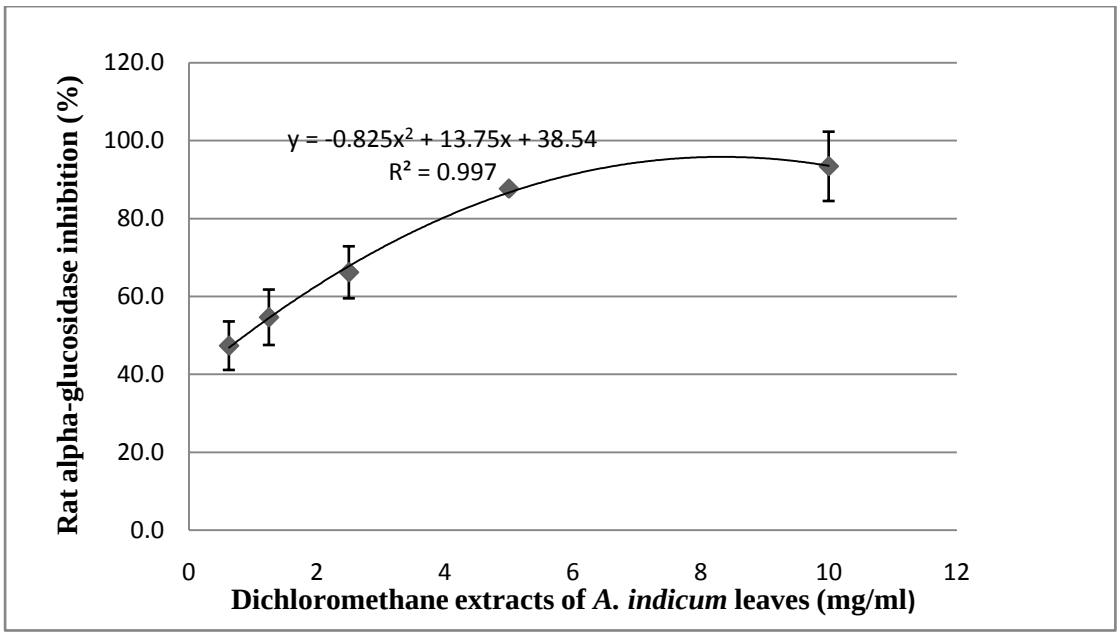


Figure 72 Rat alpha-glucosidase inhibition of dichloromethane extracts of *A. indicum* leaves

Table 82 Rat alpha-glucosidase inhibition of methanolic extracts of *A. indicum* leaves

Methanolic extracts of *A. indicum* leaves (mg/ml)	OD_{405} (reaction mixture)			Rat alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	0.785	0.762	0.869					
0.31	0.791	0.747	0.874	9.2	4.5	10.7	8.1	3.2
0.63	0.781	0.724	0.875	18.5	17.2	17.9	17.9	0.6
1.25	0.854	0.753	0.832	31.6	33.4	38.2	34.4	3.4
5.00	0.957	1.058	1.008	52.9	59.2	51.5	54.5	4.1
10.00	1.419	1.336	1.389	63.3	70.9	70.7	68.3	4.3

Methanolic extracts of *A. indicum* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.676	0.634	0.653
0.31	0.147	0.147	0.145
0.63	0.203	0.204	0.205
1.25	0.369	0.335	0.328
5.00	0.623	0.802	0.612
10.00	1.159	1.153	1.15

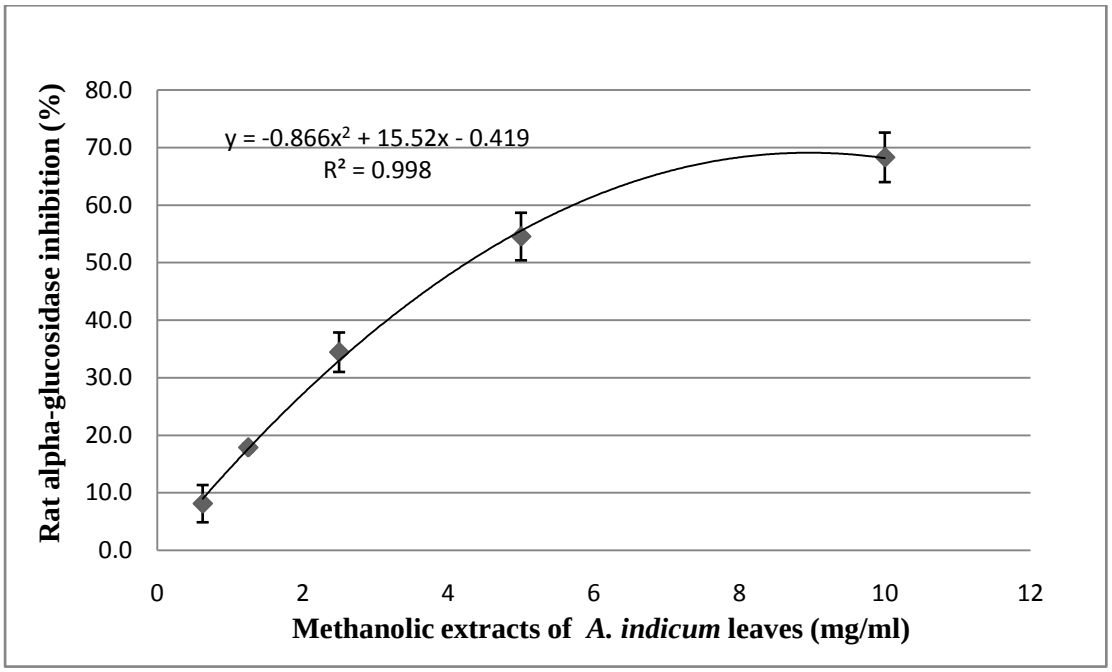


Figure 73 Rat alpha-glucosidase inhibition of methanolic extracts of *A. indicum* leaves

Table 83 Rat alpha-glucosidase inhibition of dichloromethane extracts of *A. indicum* roots

Dichloromethane extracts of *A. indicum* roots (mg/ml)	OD_{405} (reaction mixture)			Rat alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	0.785	0.762	0.869					
0.16	0.791	0.707	0.874	13.0	11.8	12.7	12.5	0.6
0.31	0.831	0.768	0.854	26.0	23.6	23.8	24.4	1.3
0.63	0.846	0.807	0.895	41.3	40.6	42.3	41.1	0.4
1.25	0.922	0.918	0.978	70.1	62.3	67.9	66.8	4.0
2.50	1.365	1.385	1.384	98.4	96.5	99.8	98.2	1.6

Dichloromethane extracts of *A. indicum* roots (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.676	0.634	0.653
0.16	0.174	0.153	0.162
0.31	0.306	0.288	0.232
0.63	0.43	0.434	0.416
1.25	0.71	0.681	0.716
2.50	1.354	1.363	1.382

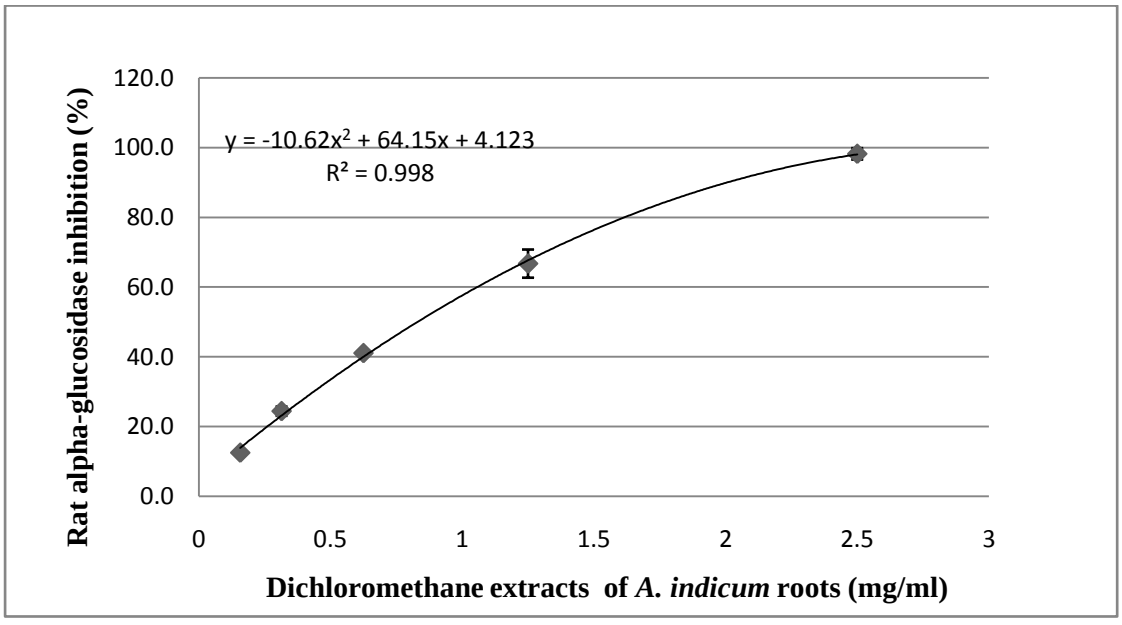


Figure 74 Rat alpha-glucosidase inhibition of dichloromethane extracts of *A. indicum* roots

Table 84 Rat alpha-glucosidase inhibition of methanolic extracts of *A. indicum* roots

Methanolic extracts of *A. indicum* roots (mg/ml)	OD_{405} (reaction mixture)			Rat alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	0.785	0.762	0.869					
0.31	0.719	0.659	0.76	16.9	12.3	21.2	16.8	4.5
0.63	0.672	0.642	0.722	22.7	20.7	28.7	24.0	4.1
1.25	0.762	0.608	0.757	28.1	36.1	36.6	33.6	4.8
5.00	0.805	0.795	0.794	52.0	52.7	46.4	50.4	3.4
10.00	0.935	0.905	0.927	75.2	66.7	69.4	70.4	4.3

Methanolic extracts of *A. indicum* roots (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.076	0.134	0.053
0.31	0.13	0.108	0.117
0.63	0.124	0.144	0.14
1.25	0.252	0.207	0.24
5.00	0.465	0.498	0.357
10.00	0.759	0.696	0.677

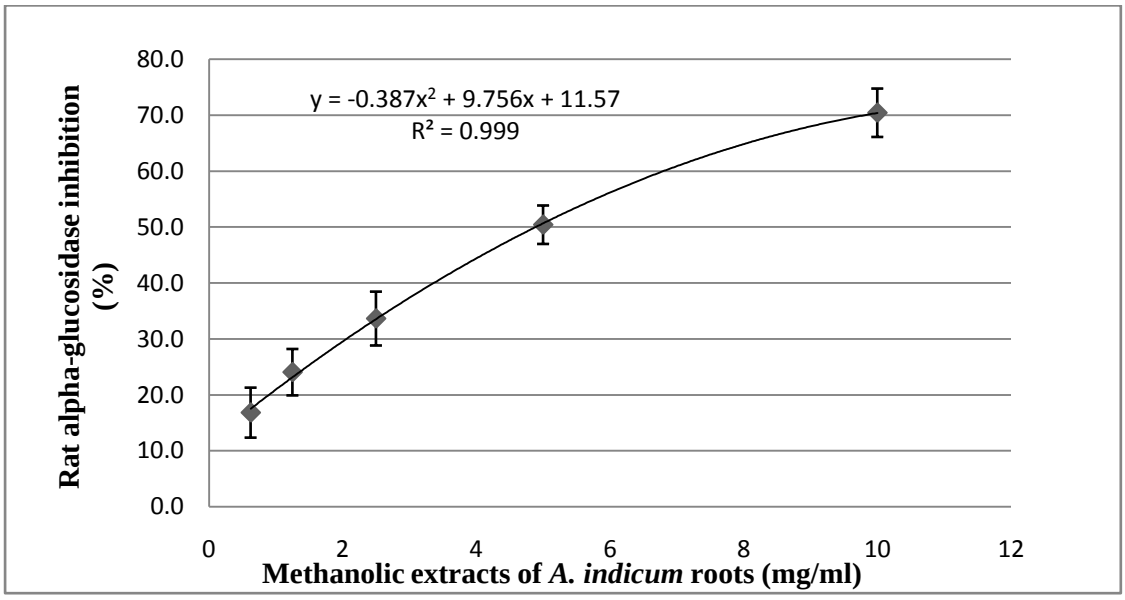


Figure 75 Rat alpha-glucosidase inhibition of methanolic extracts of *A. indicum* roots

Table 85 Rat alpha-glucosidase inhibition of dichloromethane extracts of *A. indicum* stems

Dichloromethane extracts of *A. indicum* stems (mg/ml)	OD_{405} (reaction mixture)			Rat alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	0.785	0.762	0.869					
0.31	0.769	0.668	0.814	2.5	8.3	10.0	7.0	3.9
0.63	0.701	0.671	0.783	13.8	13.7	18.3	15.3	2.6
1.25	0.794	0.741	0.788	28.6	30.7	31.9	30.4	1.6
5.00	0.777	0.746	0.805	51.1	50.3	52.3	51.2	1.0
10.00	0.945	0.855	0.937	73.8	71.7	70.5	72.0	1.7

Dichloromethane extracts of *A. indicum* stems (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.076	0.134	0.053
0.31	0.078	0.092	0.08
0.63	0.09	0.129	0.116
1.25	0.288	0.306	0.232
5.00	0.43	0.434	0.416
10.00	0.759	0.677	0.696

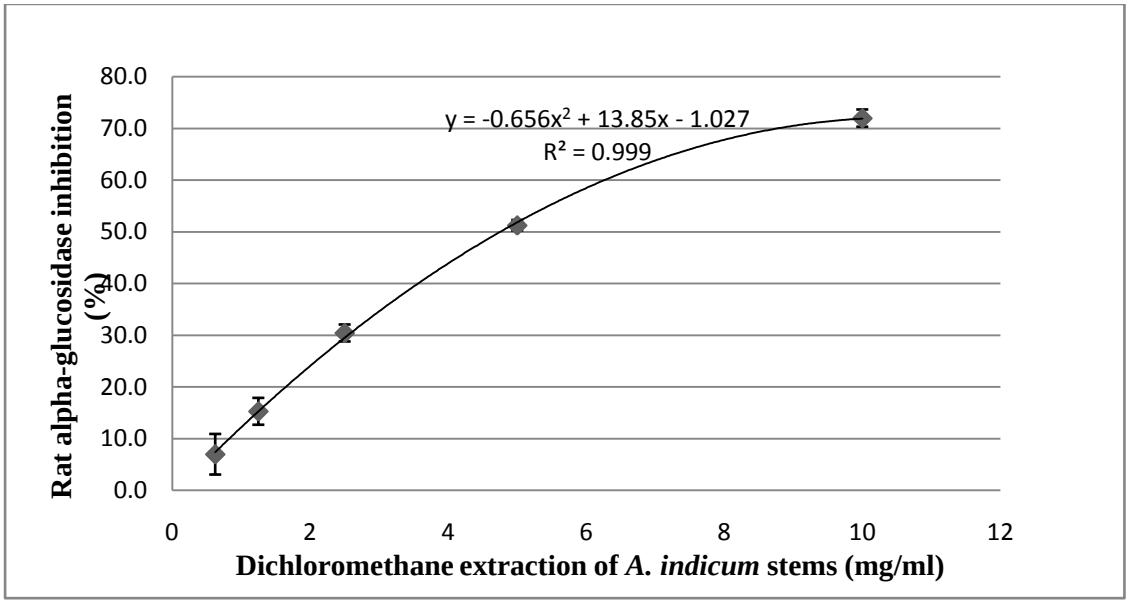


Figure 76 Rat alpha-glucosidase inhibition of dichloromethane extracts of *A. indicum* stems

Table 86 Rat alpha-glucosidase inhibition of methanolic extracts of *A. indicum* stems

Methanolic extracts of *A. indicum* stems (mg/ml)	OD_{405} (reaction mixture)			Rat alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	0.847	0.817	0.874					
0.31	0.815	0.792	0.861	5.2	2.3	7.9	5.1	2.8
0.63	0.776	0.715	0.852	11.1	12.4	10.0	11.1	1.2
1.25	0.706	0.645	0.752	23.2	21.6	19.8	21.5	1.7
5.00	0.742	0.762	0.912	39.5	41.2	42.4	41.0	1.5
10.00	0.783	0.887	0.871	63.5	67.6	66.1	65.7	2.1

Methanolic extracts of *A. indicum* stems (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.072	0.089	0.025
0.31	0.08	0.081	0.079
0.63	0.087	0.077	0.087
1.25	0.111	0.074	0.07
5.00	0.273	0.334	0.421
10.00	0.5	0.651	0.58

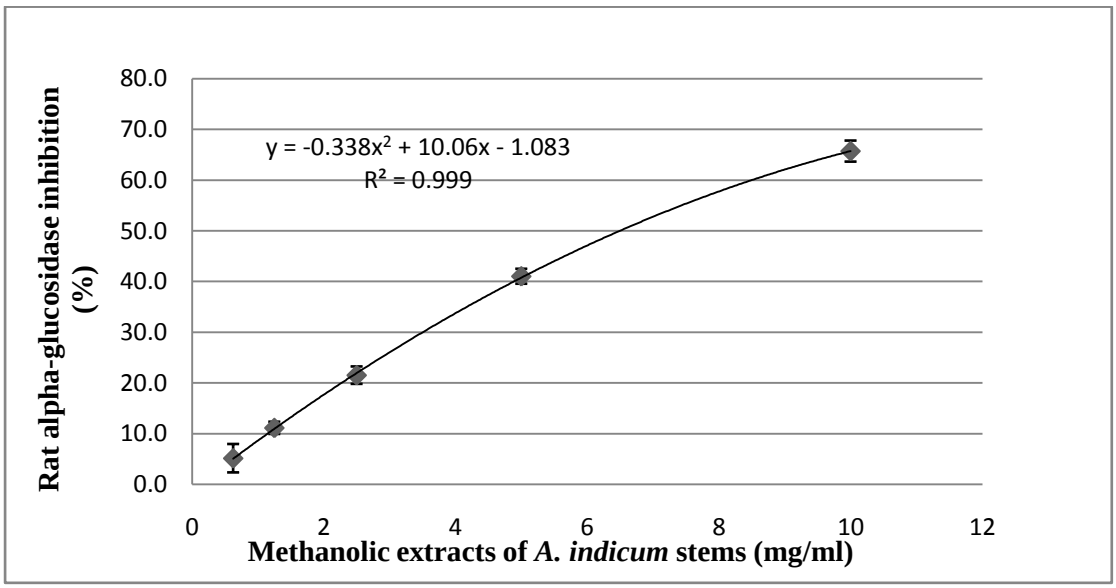


Figure 77 Rat alpha-glucosidase inhibition of methanolic extracts of *A. indicum* stems

Table 87 Rat alpha-glucosidase inhibition of 1-Deoxynojirimycin

1-Deoxynojirimycin (mg/ml)	OD_{405} (reaction mixture)			Rat alpha-glucosidase inhibition (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	1.394	1.122	1.114					
0.002	1.272	1.031	1.021	6.0	6.3	7.1	6.5	0.6
0.005	1.191	0.999	0.981	12.1	10.0	11.6	11.3	1.1
0.01	1.091	0.909	0.911	20.9	18.5	19.2	19.5	1.3
0.02	0.988	0.901	0.892	29.3	21.0	21.3	23.9	4.7
0.05	0.981	0.818	0.819	31.0	29.4	29.6	30.0	0.9
0.09	0.854	0.645	0.661	42.0	48.0	46.5	45.5	3.1
0.19	0.762	0.576	0.575	50.6	55.6	55.8	54.0	3.0
0.38	0.631	0.546	0.555	64.6	64.0	62.2	63.6	1.2
0.75	0.798	0.761	0.768	81.8	81.0	80.1	81.0	0.8
1.50	1.002	1.007	1.001	89.1	90.1	91.8	90.3	1.3

1-Deoxynojirimycin (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.051	0.033	0.023
0.002	0.009	0.011	0.008
0.005	0.011	0.019	0.017
0.01	0.029	0.021	0.029
0.02	0.039	0.041	0.033
0.05	0.055	0.049	0.051
0.09	0.075	0.079	0.077
0.19	0.098	0.093	0.093
0.38	0.155	0.154	0.143
0.75	0.553	0.554	0.551
1.50	0.856	0.899	0.911

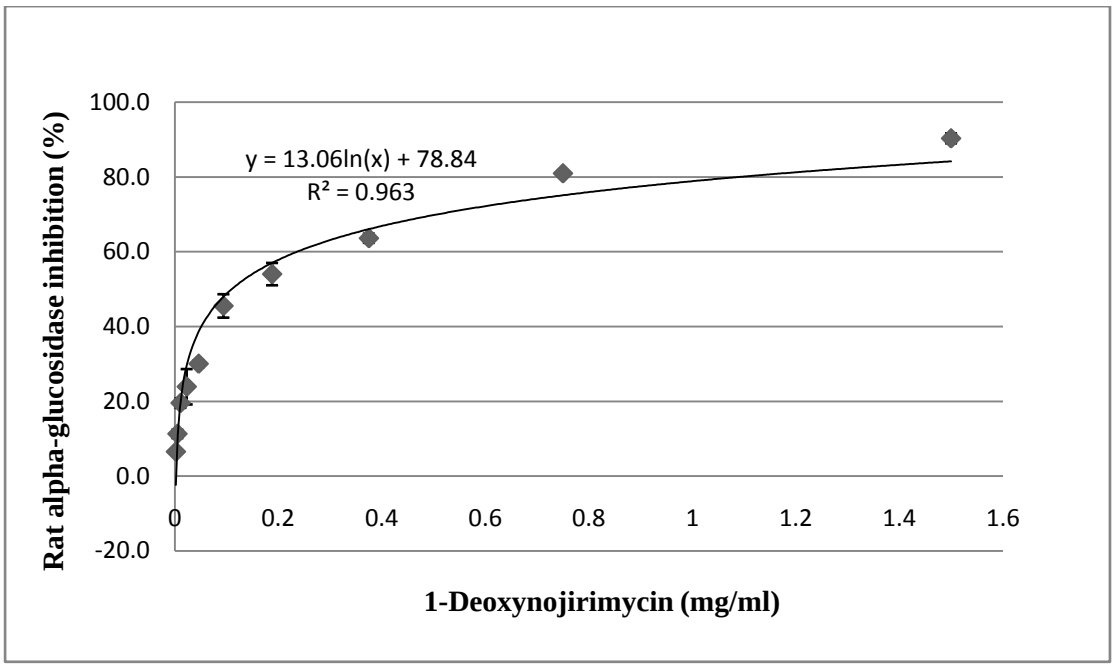


Figure 78 Rat alpha-glucosidase inhibition of 1-Deoxynojirimycin

Table 88 DPPH scavenging activity of dichloromethane extracts of *S. acuta* leaves

Dichloromethane extracts of *S. acuta* leaves (mg/ml)	OD_{405} (reaction mixture)			DPPH scavenging (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	0.518	0.538	0.599					
0.06	0.457	0.476	0.522	16.2	15.3	10.3	13.9	3.2
0.13	0.454	0.471	0.524	18.1	20.6	12.8	17.2	4.0
0.25	0.422	0.447	0.507	24.3	24.9	17.8	22.3	3.9
0.50	0.445	0.433	0.456	23.4	31.0	29.8	28.1	4.1
1.00	0.305	0.327	0.333	55.3	57.3	56.3	56.3	1.0

Dichloromethane extracts of *S. acuta* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.048	0.048	0.053
0.06	0.063	0.061	0.068
0.13	0.069	0.082	0.083
0.25	0.066	0.079	0.091
0.50	0.085	0.095	0.101
1.00	0.095	0.118	0.112

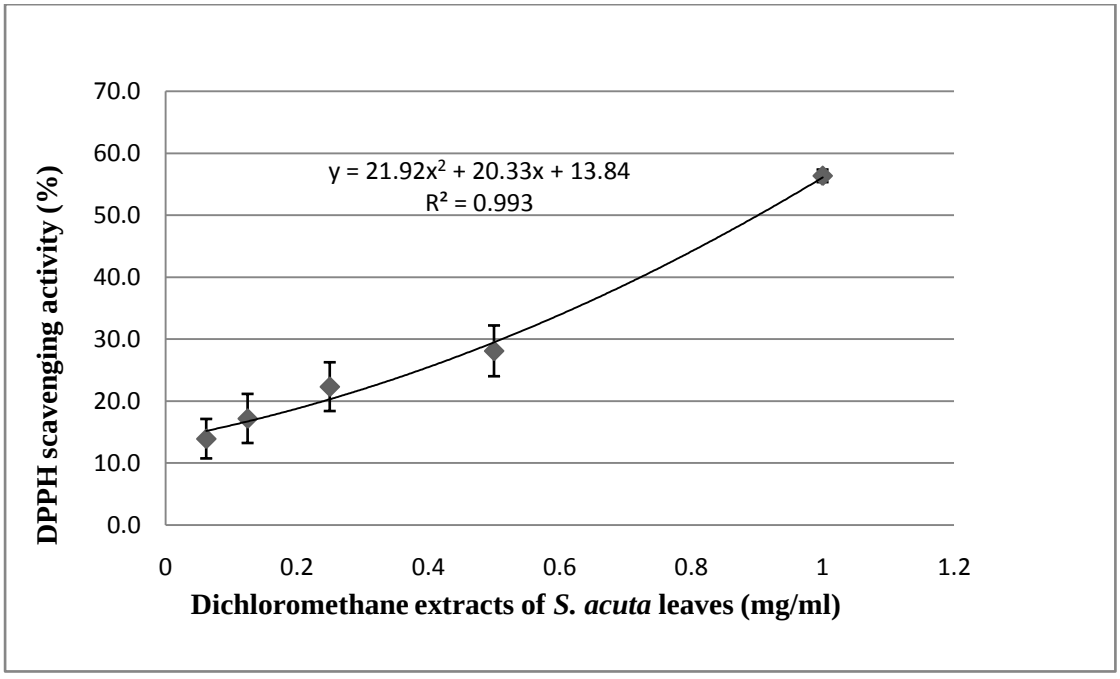


Figure 79 DPPH scavenging activity of dichloromethane extracts of *S. acuta* leaves

Table 89 DPPH scavenging activity of methanolic extracts of *S. acuta* leaves

Methanolic extracts of *S. acuta* leaves (mg/ml)	OD_{405} (reaction mixture)			DPPH scavenging (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	0.648	0.64	0.645					
0.06	0.591	0.566	0.569	10.9	13.1	14.0	12.7	1.6
0.13	0.529	0.495	0.482	22.3	27.1	29.4	26.3	3.6
0.25	0.423	0.398	0.399	41.6	44.3	44.8	43.6	1.7
0.50	0.295	0.271	0.265	67.4	72.6	71.8	70.6	2.8
1.00	0.188	0.195	0.191	93.8	92.2	92.2	92.7	0.9

Methanolic extracts of *S. acuta* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.052	0.053	0.053
0.06	0.06	0.056	0.06
0.13	0.066	0.067	0.064
0.25	0.075	0.071	0.072
0.50	0.101	0.11	0.098
1.00	0.151	0.149	0.145

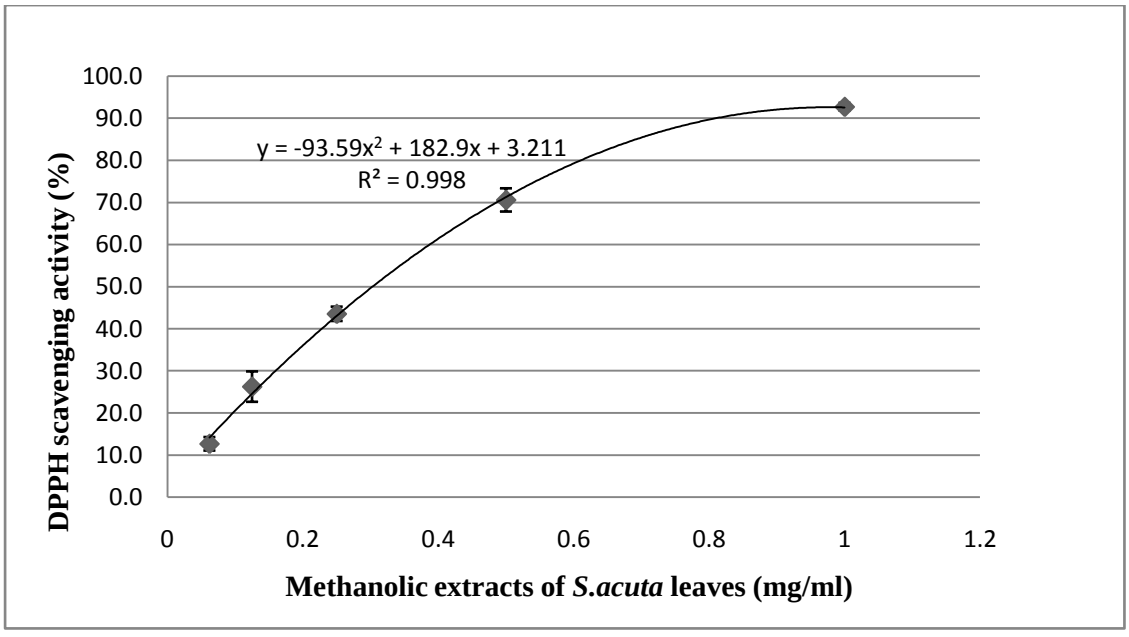


Figure 80 DPPH scavenging activity of methanolic extracts of *S. acuta* leaves

Table 90 DPPH scavenging activity of dichloromethane extracts of *S. acuta* roots

Dichloromethane extracts of *S. acuta* roots (mg/ml)	OD_{405} (reaction mixture)			DPPH scavenging (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	0.689	0.661	0.671					
0.03	0.651	0.615	0.611	4.7	4.9	9.3	6.3	2.6
0.06	0.606	0.589	0.585	13.7	12.8	15.4	14.0	1.3
0.13	0.492	0.465	0.471	34.3	34.7	34.0	34.3	0.4
0.25	0.337	0.318	0.306	58.3	59.5	61.7	59.9	1.7
0.50	0.197	0.166	0.16	81.8	86.2	87.5	85.1	3.0
1.00	0.182	0.196	0.207	89.8	87.2	87.2	88.0	1.5

Dichloromethane extracts of *S. acuta* roots (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.053	0.053	0.047
0.03	0.045	0.037	0.045
0.06	0.057	0.059	0.057
0.13	0.074	0.068	0.059
0.25	0.072	0.072	0.067
0.50	0.081	0.082	0.082
1.00	0.117	0.118	0.127

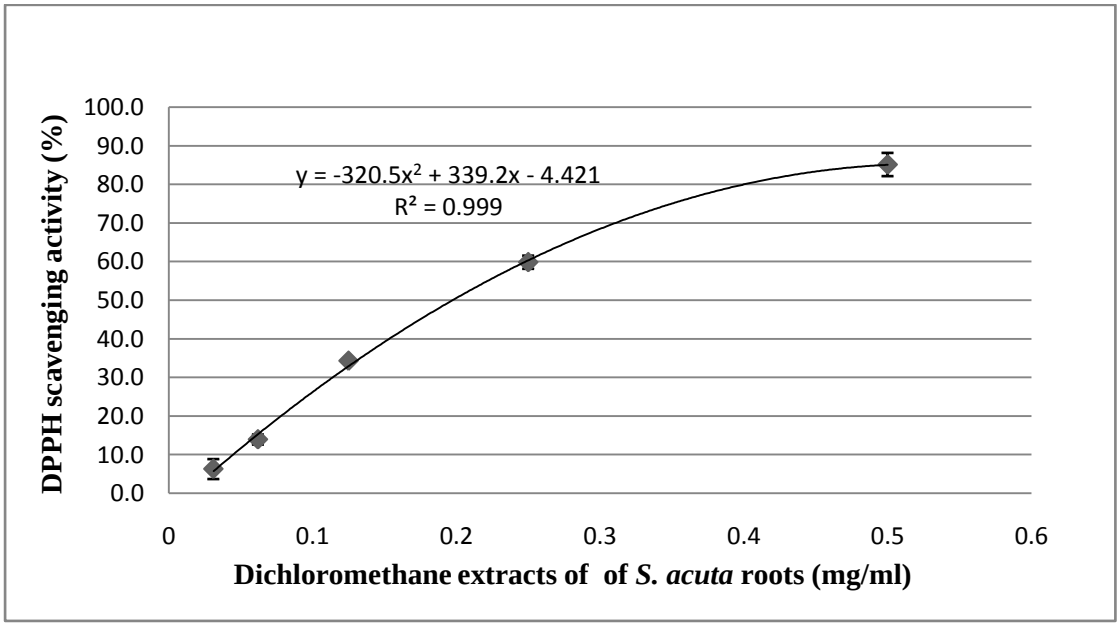


Figure 81 DPPH scavenging activity of dichloromethane extracts of *S. acuta* roots

Table 91 DPPH scavenging activity of methanolic extracts of *S. acuta* roots

Methanolic extracts of *S. acuta* roots (mg/ml)	OD_{405} (reaction mixture)			DPPH scavenging (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	0.6	0.575	0.6					
0.06	0.564	0.534	0.529	7.3	6.2	14.1	9.2	4.3
0.13	0.542	0.525	0.511	11.7	8.3	15.8	11.9	3.7
0.25	0.476	0.453	0.45	23.9	23.4	28.3	25.2	2.7
0.50	0.371	0.377	0.373	44.3	40.2	43.7	42.7	2.2
1.00	0.272	0.252	0.23	64.1	65.8	71.4	67.1	3.8

Methanolic extracts of *S. acuta* roots (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.051	0.058	0.055
0.06	0.055	0.049	0.061
0.13	0.057	0.051	0.052
0.25	0.058	0.057	0.059
0.50	0.065	0.068	0.066
1.00	0.075	0.075	0.074

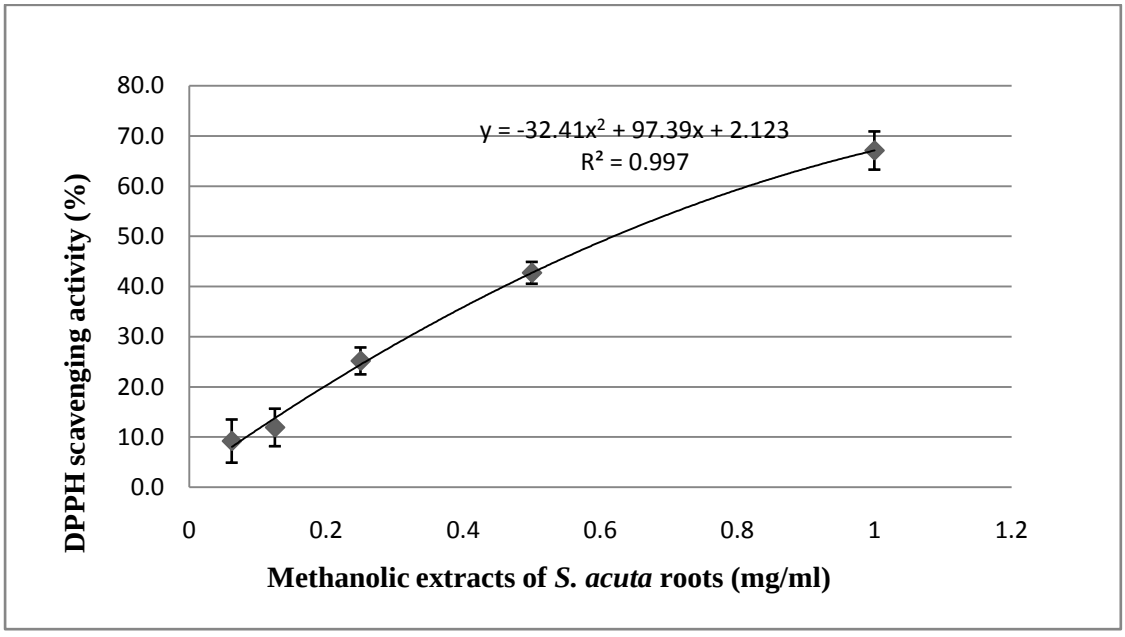


Figure 82 DPPH scavenging activity of methanolic extracts of *S. acuta* roots

Table 92 DPPH scavenging activity of dichloromethane extracts of *S. acuta* stems

Dichloromethane extracts of *S. acuta* stems (mg/ml)	OD_{405} (reaction mixture)			DPPH scavenging (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	0.689	0.661	0.671					
0.03	0.651	0.637	0.622	4.7	2.3	96.6	4.5	2.1
0.06	0.643	0.637	0.651	7.5	5.3	5.0	5.9	1.4
0.13	0.545	0.552	0.536	24.5	18.6	26.4	23.2	4.1
0.25	0.438	0.436	0.446	42.5	41.9	40.7	41.7	0.9
0.50	0.265	0.247	0.238	71.1	72.2	73.1	72.1	1.0
1.00	0.135	0.143	0.146	92.5	91.6	89.9	91.3	1.3

Dichloromethane extracts of *S. acuta* stems (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.053	0.053	0.047
0.03	0.045	0.043	0.039
0.06	0.055	0.061	0.058
0.13	0.065	0.057	0.077
0.25	0.072	0.083	0.076
0.50	0.081	0.078	0.07
1.00	0.087	0.092	0.083

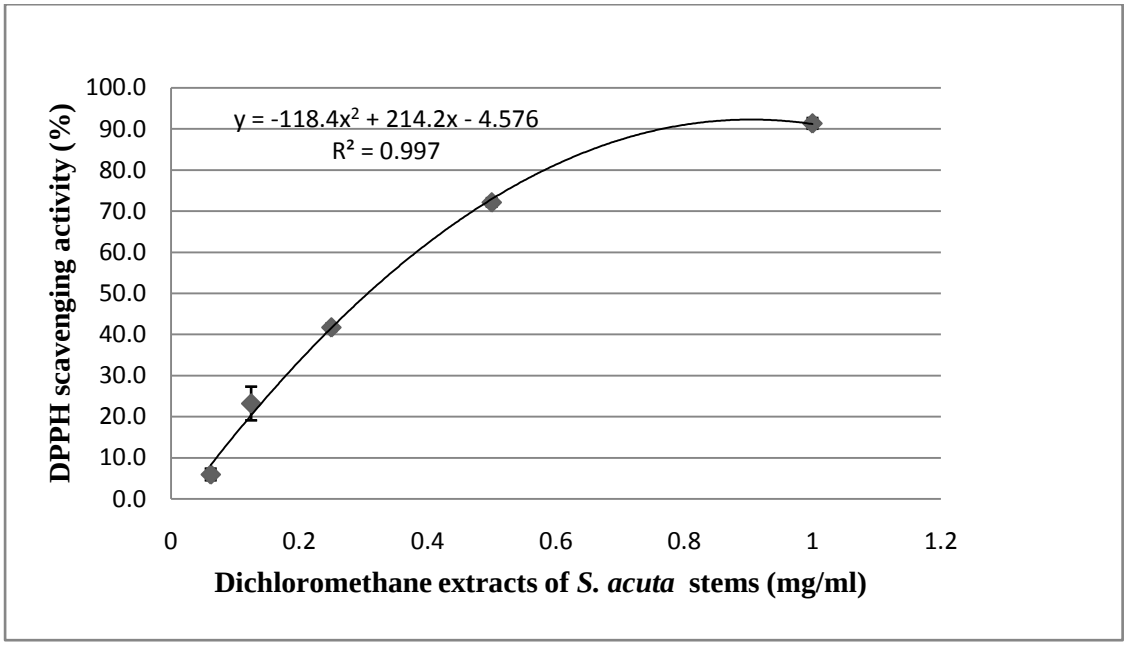


Figure 83 DPPH scavenging activity of dichloromethane extracts of *S. acuta* stems

Table 93 DPPH scavenging activity of methanolic extracts of *S. acuta* stems

Methanolic extracts of *S. acuta* stems (mg/ml)	OD_{405} (reaction mixture)			DPPH scavenging (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.0	0.611	0.602	0.609					
0.06	0.558	0.556	0.56	10.0	8.5	8.0	8.8	1.0
0.13	0.544	0.522	0.517	14.8	16.2	17.6	16.2	1.4
0.25	0.432	0.442	0.434	36.4	31.7	34.2	34.1	2.3
0.50	0.341	0.328	0.326	57.2	59.9	58.5	58.5	1.3
1.00	0.204	0.18	0.179	90.6	94.3	93.8	92.9	2.0

Methanolic extracts of *S. acuta* stems (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.0	0.05	0.059	0.059
0.06	0.053	0.059	0.054
0.13	0.066	0.067	0.064
0.25	0.075	0.071	0.072
0.50	0.101	0.11	0.098
1.00	0.151	0.149	0.145

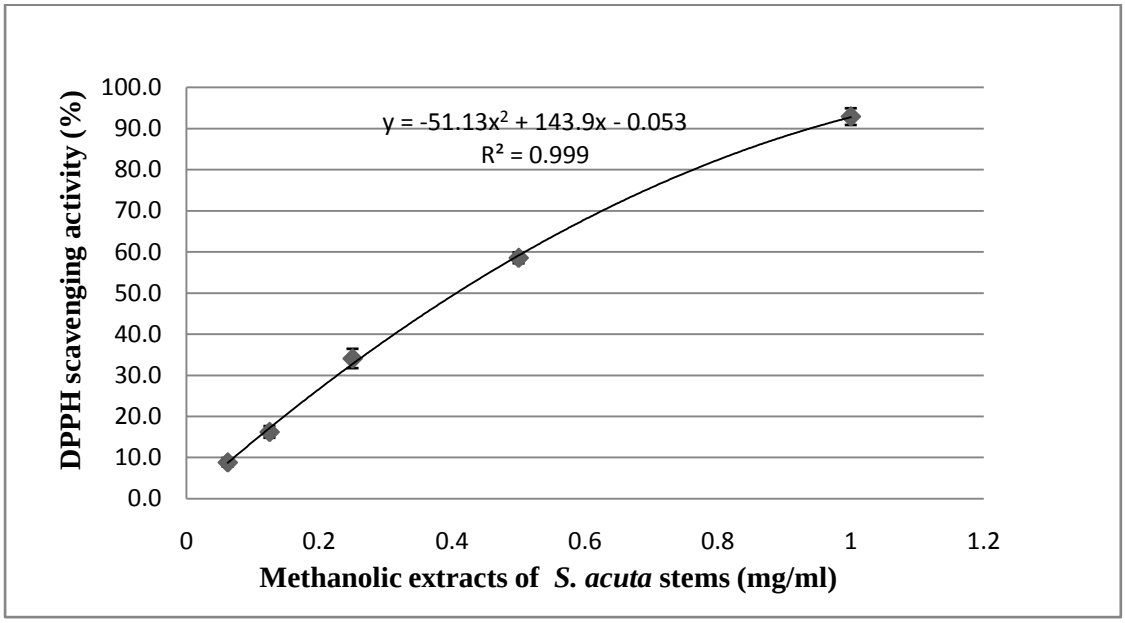


Figure 84 DPPH scavenging activity of methanolic extracts of *S. acuta* stems

Table 94 DPPH scavenging activity of Ascorbic acids

Ascorbic acids (mg/ml)	OD_{405} (reaction mixture)			DPPH scavenging (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.585	0.551	0.554					
0.001	0.525	0.471	0.518	11.6	17.5	8.5	12.5	4.6
0.003	0.527	0.822	0.492	12.7	18.6	16.5	15.9	3.0
0.01	0.432	0.417	0.412	30.8	31.3	33.8	32.0	1.6
0.02	0.331	0.253	0.243	50.8	63.0	66.0	59.9	8.0
0.03	0.084	0.079	0.078	95.9	95.6	95.5	95.6	0.2

Ascorbic acids (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.048	0.05	0.04
0.001	0.029	0.023	0.015
0.003	0.037	0.038	0.033
0.01	0.044	0.044	0.048
0.02	0.055	0.052	0.056
0.03	0.061	0.055	0.053

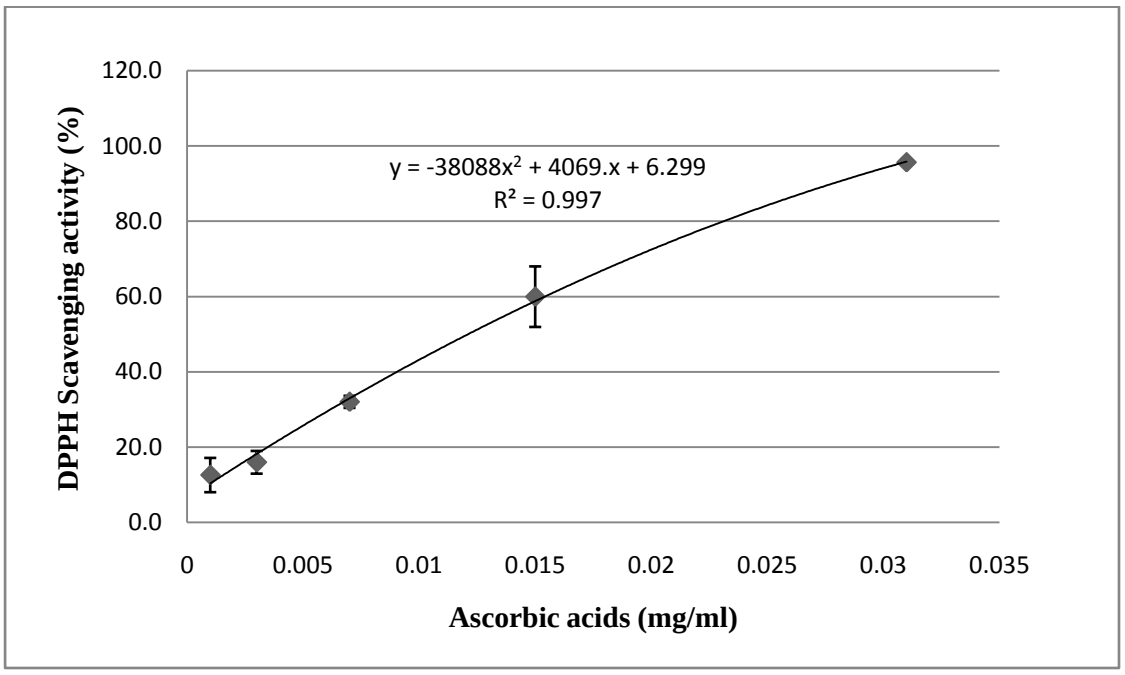


Figure 85 DPPH scavenging activity of ascorbic acids

Table 95 Nitric oxide scavenging activity of dichloromethane extracts of *S. acuta* leaves

Dichloromethane extracts of *S. acuta* leaves (mg/ml)	OD_{405} (reaction mixture)			Nitric oxide scavenging (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.4325	0.4256	0.4347					
0.02	0.3821	0.3994	0.3959	21.5	16.0	16.8	18.1	2.9
0.04	0.3931	0.4094	0.3959	26.6	28.8	28.3	27.9	1.1
0.08	0.4111	0.4101	0.3977	42.2	42.4	42.2	42.3	0.1
0.16	0.4663	0.4249	0.4595	61.0	71.5	60.2	64.2	6.3
0.32	0.5838	0.5829	0.5713	97.8	101.2	102.5	100.5	2.4

Dichloromethane extracts of *S. acuta* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.0764	0.0719	0.0813
0.02	0.1024	0.1024	0.1017
0.04	0.1319	0.1576	0.1424
0.08	0.2054	0.2065	0.1936
0.16	0.3275	0.324	0.3189
0.32	0.576	0.5872	0.58

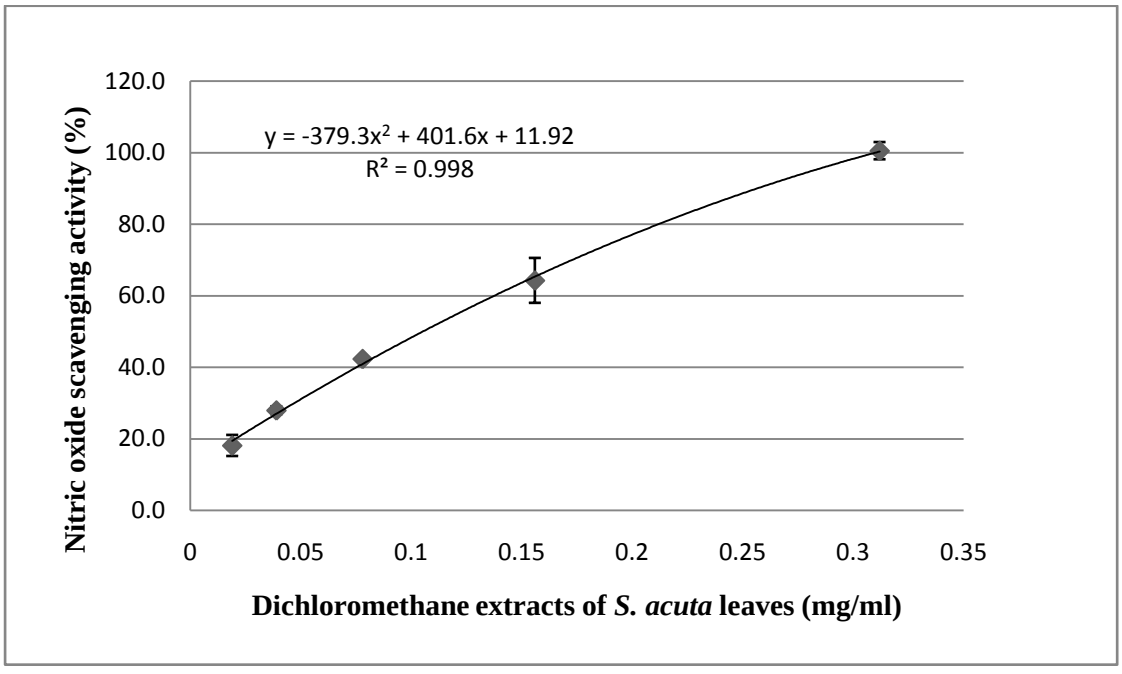


Figure 86 Nitric oxide scavenging activity of dichloromethane extracts of *S. acuta* leaves

Table 96 Nitric oxide scavenging activity of methanolic extracts of *S. acuta* leaves

Methanolic extracts of *S. acuta* leaves (mg/ml)	OD_{405} (reaction mixture)			Nitric oxide scavenging (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.4325	0.4256	0.4347					
0.08	0.3464	0.3141	0.308	28.7	37.4	40.5	35.6	6.1
0.16	0.3372	0.3108	0.3106	37.8	45.5	44.4	42.6	4.2
0.31	0.3021	0.2993	0.3247	62.4	63.6	57.3	61.1	3.4
0.63	0.3462	0.3688	0.3391	82.2	100.0	91.4	91.2	8.9
1.25	0.4806	0.4951	0.4867	112.0	115.2	114.2	113.8	1.6

Methanolic extracts of *S. acuta* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.0764	0.0719	0.0813
0.08	0.0925	0.0928	0.0978
0.16	0.1157	0.1181	0.114
0.31	0.1682	0.1705	0.1737
0.63	0.2827	0.3688	0.3086
1.25	0.5233	0.5487	0.537

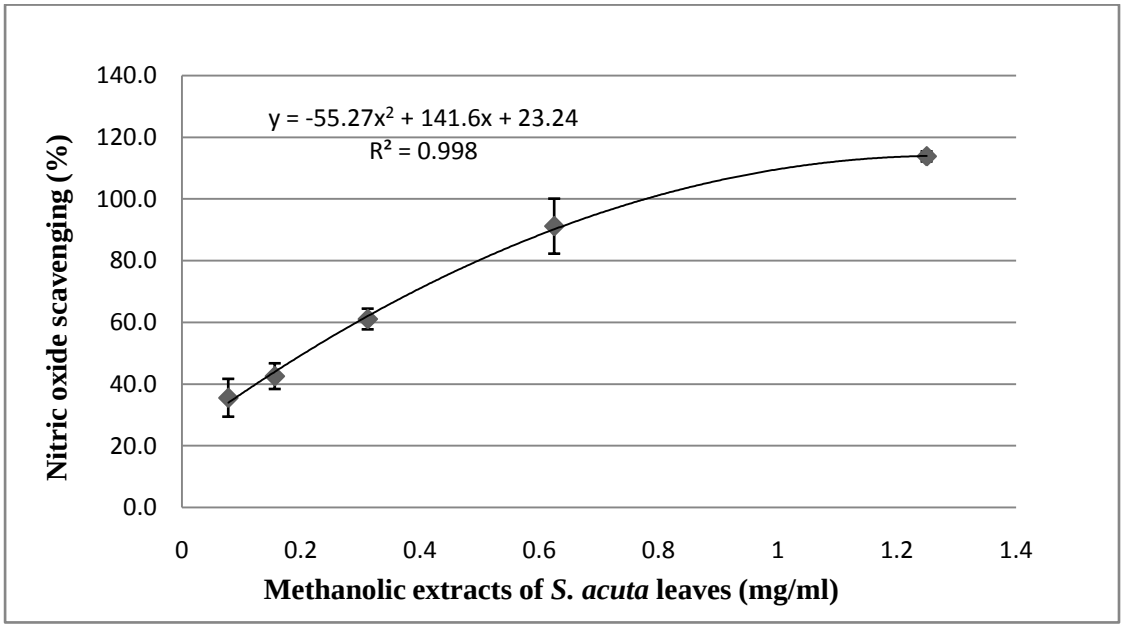


Figure 87 Nitric oxide scavenging activity of methanolic extracts of *S. acuta* leaves

Table 97 Nitric oxide scavenging activity of dichloromethane extracts of *S. acuta* roots

Dichloromethane extracts of *S. acuta* roots (mg/ml)	OD_{405} (reaction mixture)			Nitric oxide scavenging (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.6014	0.6011	0.6016					
0.16	0.5095	0.525	0.5018	19.8	19.1	19.9	19.6	0.4
0.31	0.5018	0.4738	0.4565	32.6	31.2	33.4	32.4	1.1
0.63	0.4352	0.4443	0.4456	44.9	44.0	43.0	44.0	1.0
1.25	0.4543	0.4704	0.3964	58.1	64.5	63.2	61.9	3.4
2.50	0.4687	0.4531	0.4515	85.3	87.5	87.2	86.7	1.1
5.00	0.6879	0.6736	0.5744	98.5	99.8	100.3	99.5	0.9

Dichloromethane extracts of *S. acuta* roots (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.0726	0.0701	0.0747
0.16	0.0852	0.0955	0.08
0.31	0.1452	0.1083	0.1058
0.63	0.1448	0.1468	0.1452
1.25	0.2327	0.2817	0.2023
2.50	0.3912	0.3866	0.3838
5.00	0.6799	0.6723	0.5758

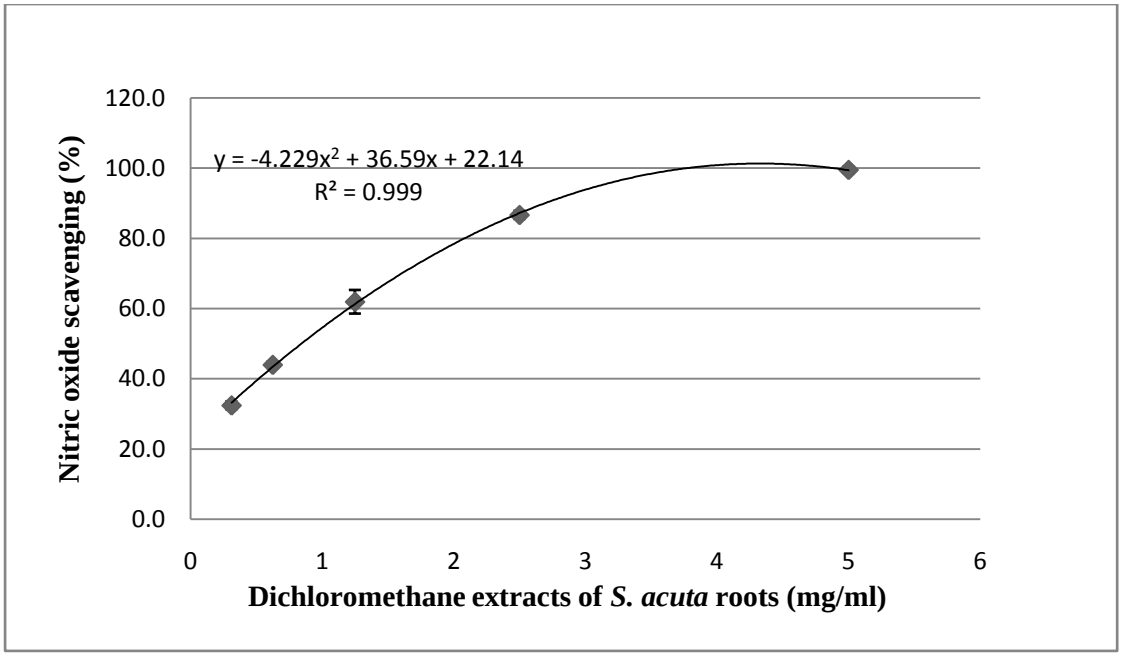


Figure 88 Nitric oxide scavenging activity of dichloromethane extracts of *S. acuta* roots

Table 98 Nitric oxide scavenging activity of methanolic extracts of *S. acuta* roots

Methanolic extracts of *S. acuta* roots (mg/ml)	OD_{405} (reaction mixture)			Nitric oxide scavenging (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.6014	0.6011	0.6016					
0.31	0.5018	0.4738	0.4565	45.1	30.2	31.7	35.7	8.2
0.63	0.4352	0.4443	0.4456	46.0	43.3	39.2	42.8	3.4
1.25	0.4543	0.4704	0.3964	57.3	56.9	51.7	55.3	3.1
2.50	0.4687	0.4531	0.4515	86.0	80.0	81.6	82.5	3.1
5.00	0.6879	0.6736	0.5744	113.3	103.6	102.2	106.4	6.1

Methanolic extracts of *S. acuta* roots (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.076	0.0743	0.0747
0.31	0.1452	0.1083	0.1058
0.63	0.1448	0.1458	0.1452
1.25	0.2237	0.2187	0.2203
2.50	0.3912	0.3966	0.3883
5.00	0.7699	0.7623	0.7558

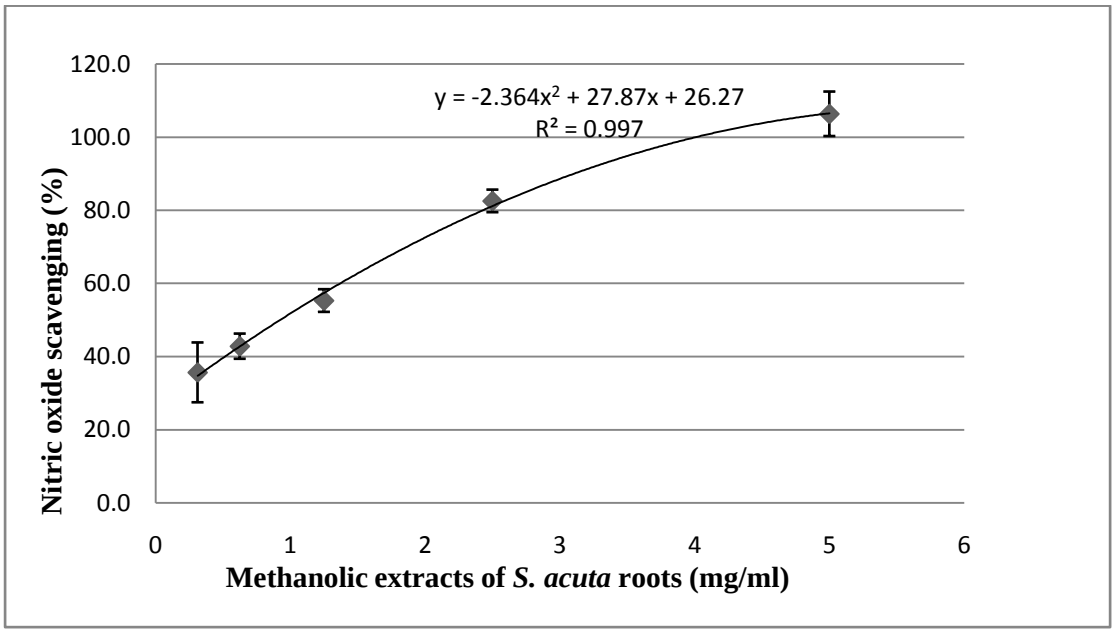


Figure 89 Nitric oxide scavenging activity of methanolic extracts of *S. acuta* roots

Table 99 Nitric oxide scavenging activity of dichloromethane extracts of S. acuta stems

Dichloromethane extracts of *S. acuta* stems (mg/ml)	OD_{405} (reaction mixture)			Nitric oxide scavenging (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.614	0.5981	0.6016					
0.16	0.4611	0.4609	0.4278	33.5	33.0	39.5	35.4	3.6
0.31	0.382	0.4094	0.4603	52.3	47.1	36.3	45.2	8.2
0.63	0.4465	0.4751	0.4755	50.0	41.0	45.4	45.4	4.5
1.25	0.5211	0.511	0.507	55.0	55.3	54.5	54.9	0.4
2.50	0.6408	0.6202	0.5899	71.5	73.3	75.9	73.7	2.2
5.00	0.8443	0.8764	0.8504	96.9	94.3	92.7	94.6	2.2

Dichloromethane extracts of *S. acuta* stems (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.076	0.0743	0.0747
0.16	0.1021	0.1101	0.1091
0.31	0.1249	0.1321	0.1246
0.63	0.1763	0.1658	0.1878
1.25	0.278	0.2771	0.2671
2.50	0.4871	0.4822	0.463
5.00	0.8278	0.8463	0.8118

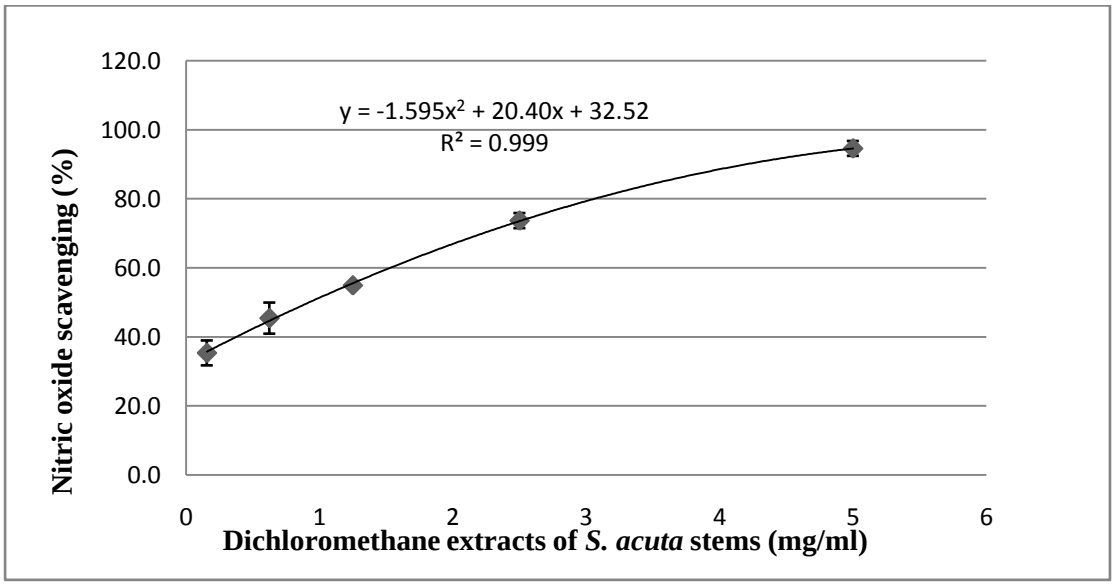


Figure 90 Nitric oxide scavenging activity of dichloromethane extracts of *S. acuta* stems

Table 100 Nitric oxide scavenging activity of methanolic extracts of *S. acuta* stems

Methanolic extracts of *S. acuta* stems (mg/ml)	OD_{405} (reaction mixture)			Nitric oxide scavenging (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.6023	0.6011	0.6011					
0.31	0.4828	0.5094	0.4773	36.2	32.5	34.7	34.5	1.9
0.63	0.5165	0.4751	0.5177	38.3	43.0	35.6	38.9	3.7
1.25	0.5412	0.511	0.5007	48.1	56.4	56.5	53.7	4.8
2.50	0.6388	0.6341	0.6446	73.0	73.0	71.8	72.6	0.7
5.00	0.9493	0.9118	0.9178	99.5	100.0	100.0	99.8	0.3

Methanolic extracts of *S. acuta* stems (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.0566	0.0747	0.0747
0.31	0.1349	0.1541	0.1336
0.63	0.1796	0.1748	0.1788
1.25	0.2578	0.2817	0.2715
2.50	0.4917	0.4922	0.4963
5.00	0.9463	0.9118	0.9178

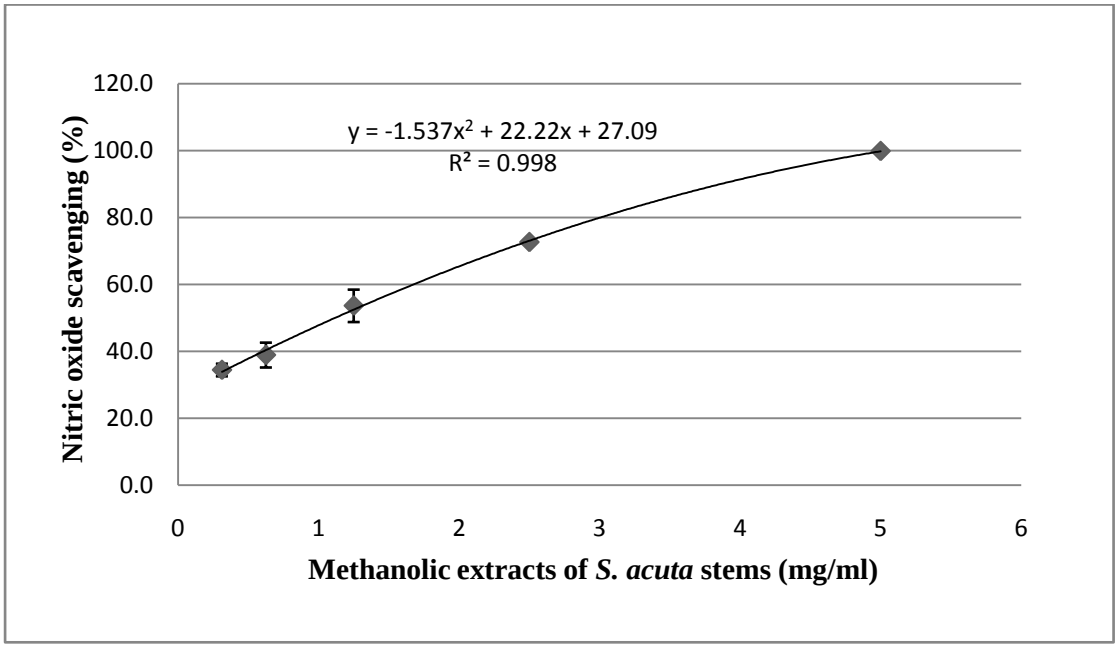


Figure 91 Nitric oxide scavenging activity of methanolic extracts of *S. acuta* stems

Table 101 Nitric oxide scavenging activity of Quercetin

Quercetin (mg/ml)	OD_{405} (reaction mixture)			Nitric oxide scavenging (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.6023	0.6011	0.6011					
0.001	0.5122	0.5221	0.5111	7.9	2.1	4.6	4.9	2.9
0.003	0.4612	0.4762	0.4601	17.4	11.6	14.5	14.5	2.9
0.007	0.4321	0.3882	0.3821	23.1	28.7	31.3	27.7	4.2
0.02	0.3222	0.3252	0.3022	44.5	41.3	46.6	44.1	2.7
0.03	0.2948	0.2858	0.2902	53.1	49.7	49.5	50.8	2.0
0.06	0.2911	0.2866	0.2729	57.6	56.0	59.3	57.6	1.7
0.13	0.2494	0.2545	0.2337	65.6	63.2	67.3	65.4	2.1
0.25	0.2035	0.2063	0.2011	78.9	78.1	79.9	78.9	0.9
0.50	0.1512	0.1573	0.1585	90.7	89.3	90.6	90.2	0.7

Quercetin (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.0566	0.0747	0.0747
0.001	0.0098	0.0067	0.0089
0.003	0.0102	0.0111	0.0101
0.007	0.0122	0.0131	0.0202
0.02	0.0192	0.0163	0.0211
0.03	0.039	0.0212	0.0246
0.06	0.0596	0.0548	0.0588
0.13	0.0618	0.0607	0.0615
0.25	0.0881	0.0911	0.0951
0.50	0.1003	0.1012	0.1089

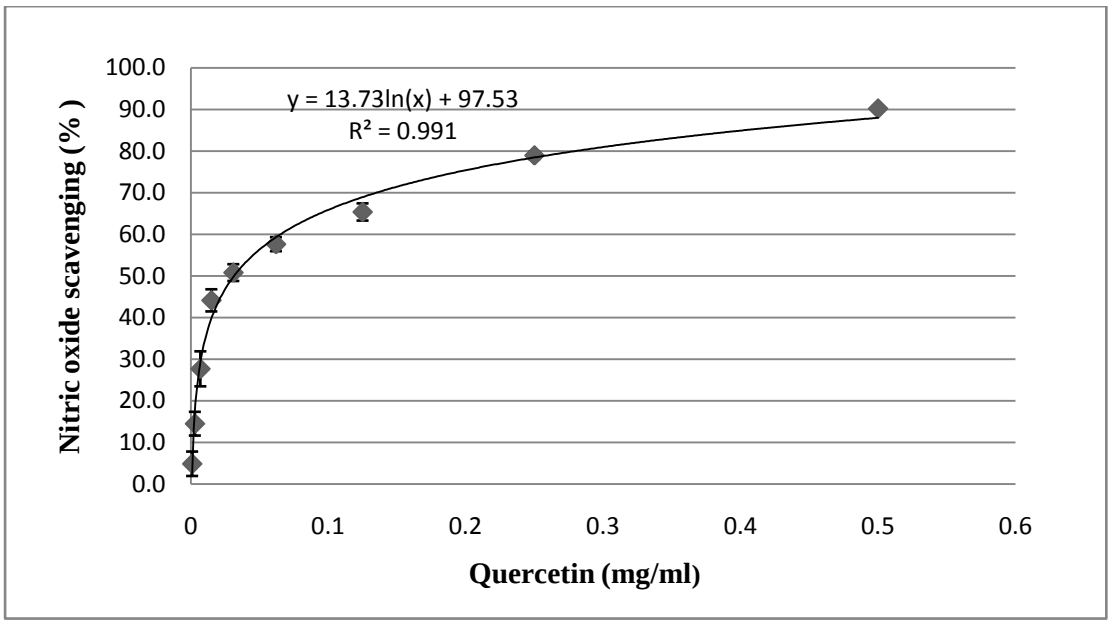


Figure 92 Nitric oxide scavenging activity of Quercetin

Table 102 Metal chelating acitivity of dichloromethane extracts of *S. acuta* leaves

Dichloromethane extracts of *S. acuta* leaves (mg/ml)	OD_{405} (reaction mixture)			Metal chelating activity (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.6348	0.5916	0.6016					
0.31	0.6424	0.5757	0.5368	1.7	13.0	19.2	11.3	8.9
0.63	0.5732	0.561	0.553	15.6	18.4	20.6	18.2	2.5
1.25	0.5245	0.5923	0.5341	34.6	42.7	42.5	39.9	4.6
2.50	0.4073	0.4587	0.4718	71.5	77.2	66.0	71.6	5.6
5.00	0.4252	0.2845	0.5035	85.8	84.3	83.4	84.5	1.2

Dichloromethane extracts of *S. acuta* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.1809	0.1612	0.1774
0.31	0.196	0.2014	0.1941
0.63	0.1903	0.2097	0.216
1.25	0.278	0.2771	0.2901
2.50	0.278	0.3604	0.3276
5.00	0.3606	0.2171	0.4332

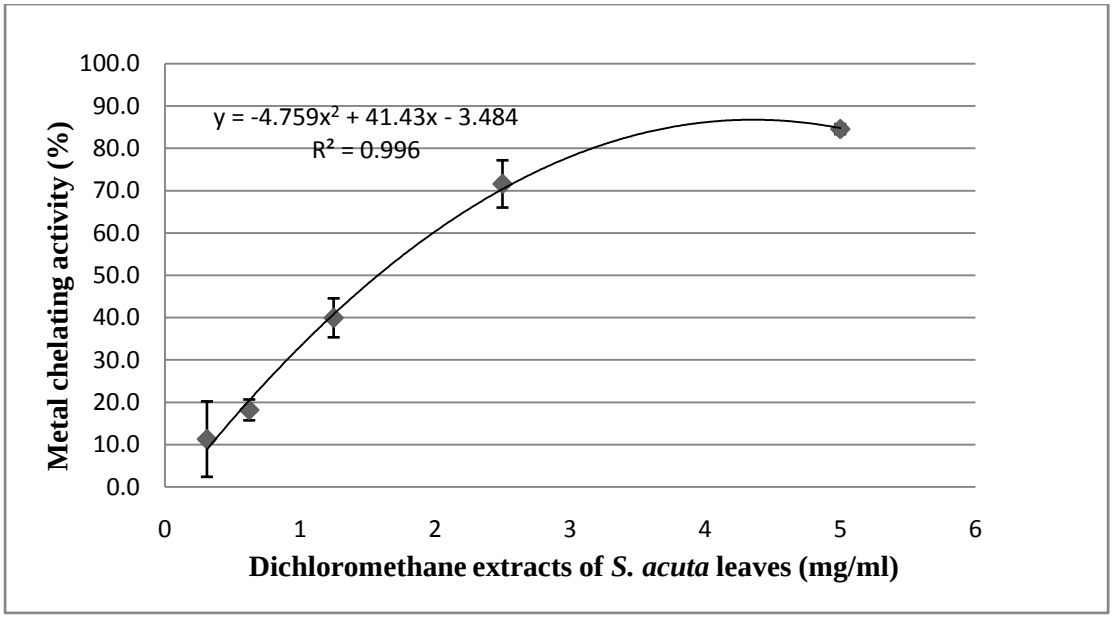


Figure 93 Metal chelating activity of dichloromethane extracts of *S. acuta* leaves

Table 103 Metal chelating activity of methanolic extracts of *S. acuta* leaves

Methanolic extracts of *S. acuta* leaves (mg/ml)	OD_{405} (reaction mixture)			Metal chelating activity (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.6348	0.5916	0.6016					
0.31	0.5726	0.5615	0.6247	3.2	8.9	5.3	5.8	2.9
0.63	0.6698	0.5981	0.6897	11.5	14.9	7.8	11.4	3.6
1.25	0.6528	0.5856	0.5682	23.8	31.6	37.5	31.0	6.8
2.50	0.4885	0.5358	0.5293	63.6	56.0	58.2	59.3	3.9
5.00	0.4347	0.4472	0.4434	82.6	83.3	79.0	81.6	2.3

Methanolic extracts of *S. acuta* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.1809	0.1612	0.1774
0.31	0.1331	0.1693	0.2229
0.63	0.2679	0.232	0.2984
1.25	0.3071	0.2912	0.303
2.50	0.3233	0.3464	0.3521
5.00	0.3556	0.3754	0.3544

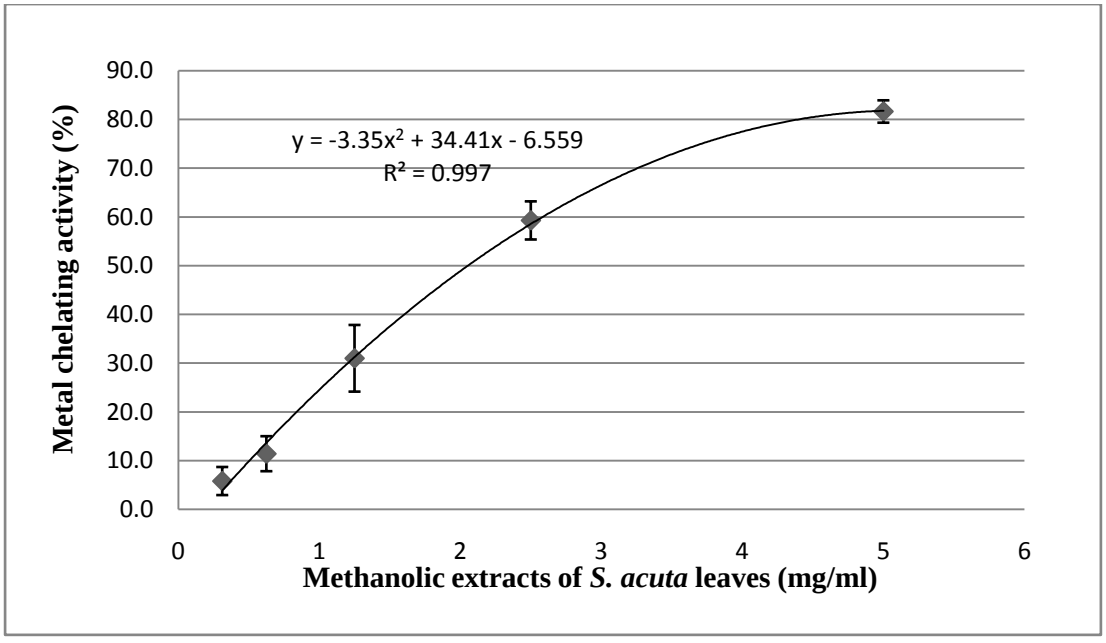


Figure 94 Metal chelating activity of methanolic extracts of *S. acuta* leaves

Table 104 Metal chelating activity of dichloromethane extracts of *S. acuta* roots

Dichloromethane extracts of *S. acuta* leaves (mg/ml)	OD_{405} (reaction mixture)			Metal chelating activity (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.6348	0.5916	0.6016					
0.31	0.5577	0.5258	0.4989	5.9	11.2	13.2	10.1	3.8
0.63	0.5646	0.4734	0.4996	10.1	22.4	12.2	14.9	6.5
1.25	0.4554	0.4769	0.4656	32.0	24.7	26.9	27.9	3.8
2.50	0.3849	0.3755	0.3885	49.4	50.8	37.5	45.9	7.3
5.00	0.2646	0.2734	0.1996	76.2	87.1	82.9	82.1	5.5

Dichloromethane extracts of *S. acuta* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.1809	0.1612	0.1774
0.31	0.1304	0.1436	0.1163
0.63	0.1567	0.1392	0.1272
1.25	0.1468	0.1527	0.1556
2.50	0.1553	0.1638	0.1232
5.00	0.1567	0.2179	0.1272

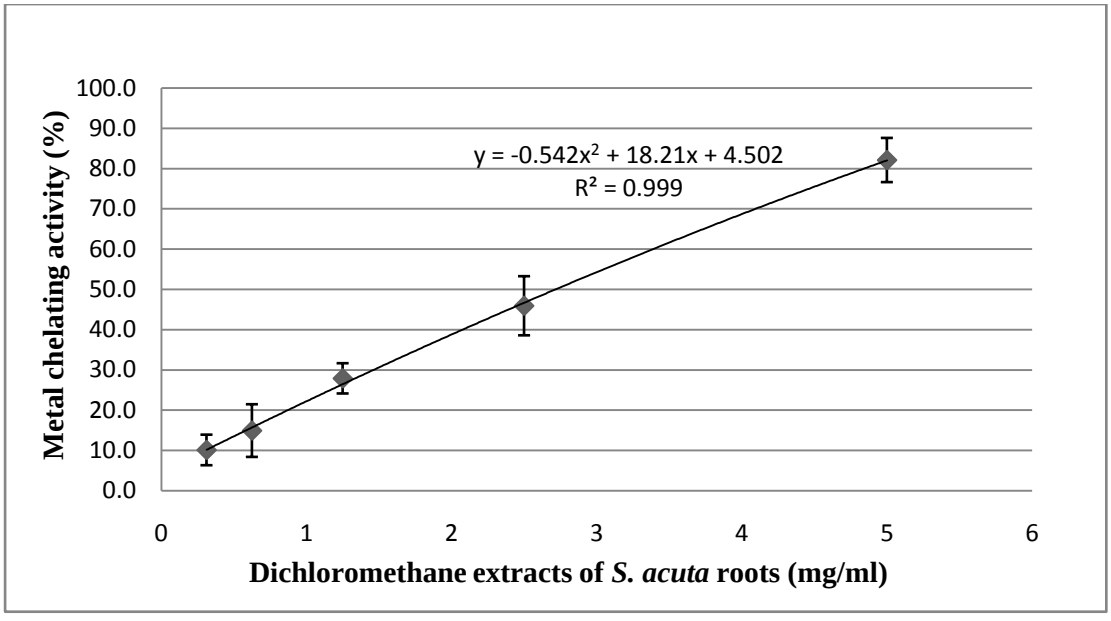


Figure 95 Metal chelating activity of dichloromethane extracts of *S. acuta* roots

Table 105 Metal chelating activity of methanolic extracts of *S. acuta* roots

Methanolic extracts of *S. acuta* roots (mg/ml)	OD_{405} (reaction mixture)			Metal chelating activity (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.5948	0.6016	0.5716					
0.31	0.6426	0.5615	0.4819	9.4	7.0	8.9	8.4	1.3
0.63	0.5698	0.5381	0.4997	20.2	22.3	22.6	21.7	1.3
1.25	0.4928	0.4856	0.4682	42.8	40.0	40.9	41.3	1.4
2.50	0.4063	0.4037	0.4067	67.8	67.2	69.4	68.1	1.1
5.00	0.3288	0.3433	0.2489	92.8	90.8	99.1	94.3	4.4

Methanolic extracts of *S. acuta* roots (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.1349	0.1822	0.1854
0.31	0.2261	0.1713	0.1299
0.63	0.2028	0.2122	0.2008
1.25	0.2299	0.2341	0.2399
2.50	0.2582	0.2662	0.2884
5.00	0.296	0.3046	0.2456

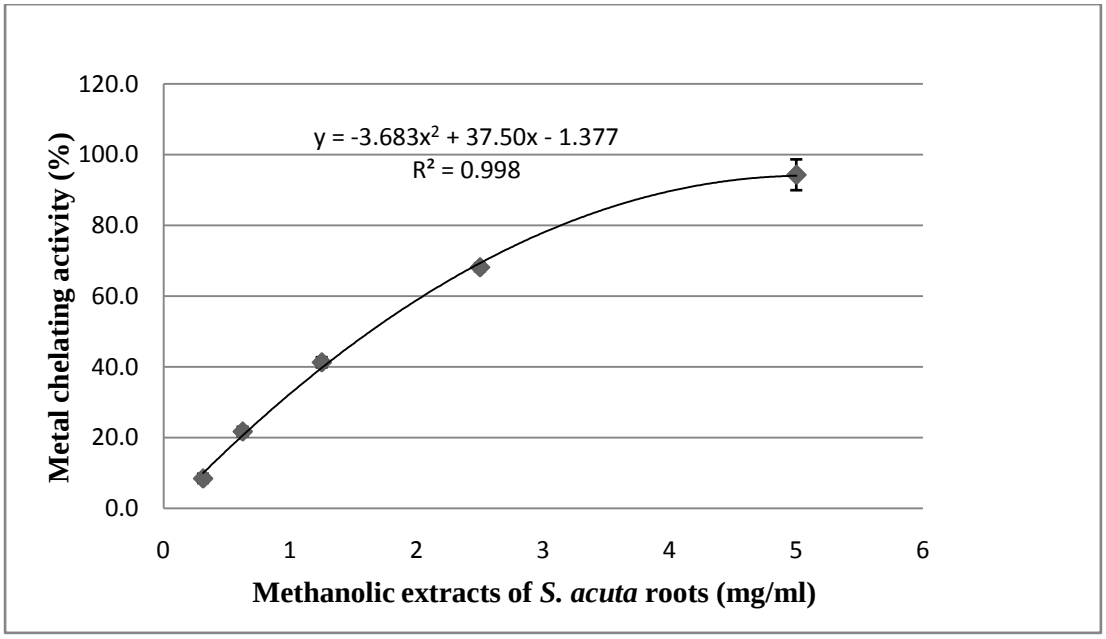


Figure 96 Metal chelating activity of methanolic extracts of *S. acuta* roots

Table 106 Metal chelating activity of dichloromethane extracts of S. acuta stems

Dichloromethane extracts of *S. acuta* leaves (mg/ml)	OD_{405} (reaction mixture)			Metal chelating activity (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.5948	0.6016	0.5716					
0.31	0.5526	0.4965	0.4919	7.3	10.5	3.7	7.2	3.4
0.63	0.5126	0.4651	0.5897	18.2	15.9	9.7	14.6	4.4
1.25	0.4554	0.4456	0.4373	33.0	27.8	24.5	28.4	4.3
2.50	0.4063	0.3037	0.3067	51.5	58.4	54.5	54.8	3.4
5.00	0.2646	0.2734	0.1996	76.9	86.8	81.3	81.6	5.0

Dichloromethane extracts of *S. acuta* leaves (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.1349	0.1822	0.1854
0.31	0.1261	0.1213	0.1199
0.63	0.1361	0.1122	0.2408
1.25	0.1468	0.1427	0.1456
2.50	0.1823	0.1291	0.1309
5.00	0.1567	0.2179	0.1272

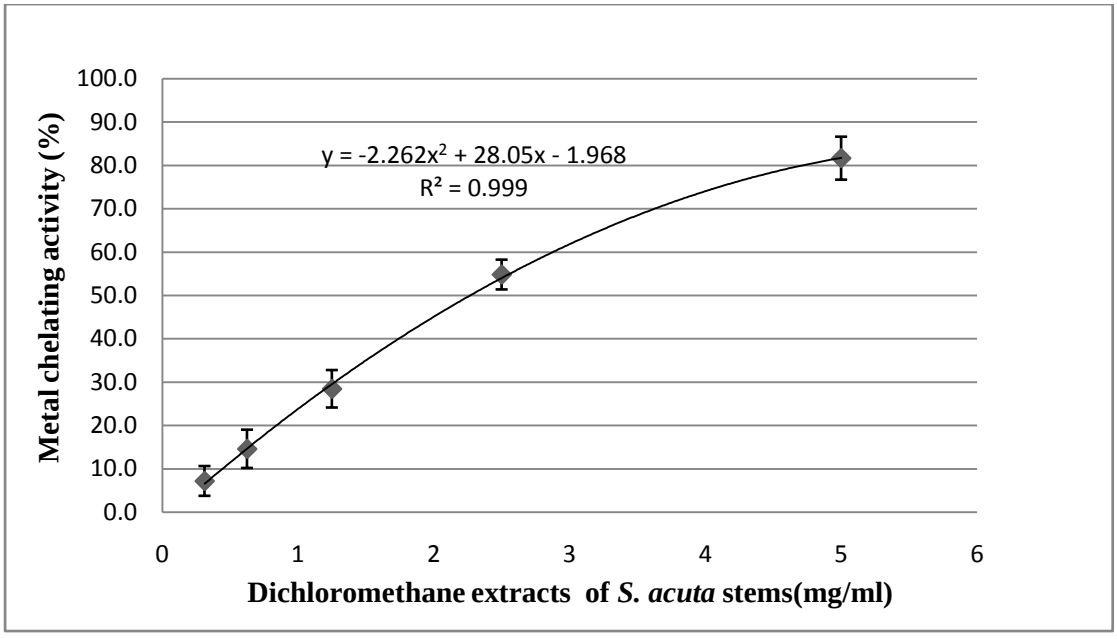


Figure 97 Metal chelating activity of dichloromethane extracts of *S. acuta* stems

Table 107 Metal chelating activity of methanolic extracts of *S. acuta* stems

Methanolic extracts of *S. acuta* stems (mg/ml)	OD_{405} (reaction mixture)			Metal chelating activity (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.5948	0.6016	0.5716					
0.31	0.5899	0.5704	0.5435	13.7	11.5	10.2	11.8	1.8
0.63	0.6003	0.5518	0.5079	18.0	18.4	21.6	19.4	2.0
1.25	0.5527	0.5327	0.4928	33.3	31.2	35.2	33.2	2.0
2.50	0.4848	0.4581	0.3536	55.0	52.2	56.1	54.4	2.0
5.00	0.4396	0.432	0.3948	66.5	61.5	69.4	65.8	4.0

Methanolic extracts of *S. acuta* stems (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.1349	0.1822	0.1854
0.31	0.1931	0.1992	0.1965
0.63	0.2234	0.2096	0.2052
1.25	0.2461	0.2487	0.2425
2.50	0.2777	0.2577	0.1842
5.00	0.2856	0.2704	0.2767

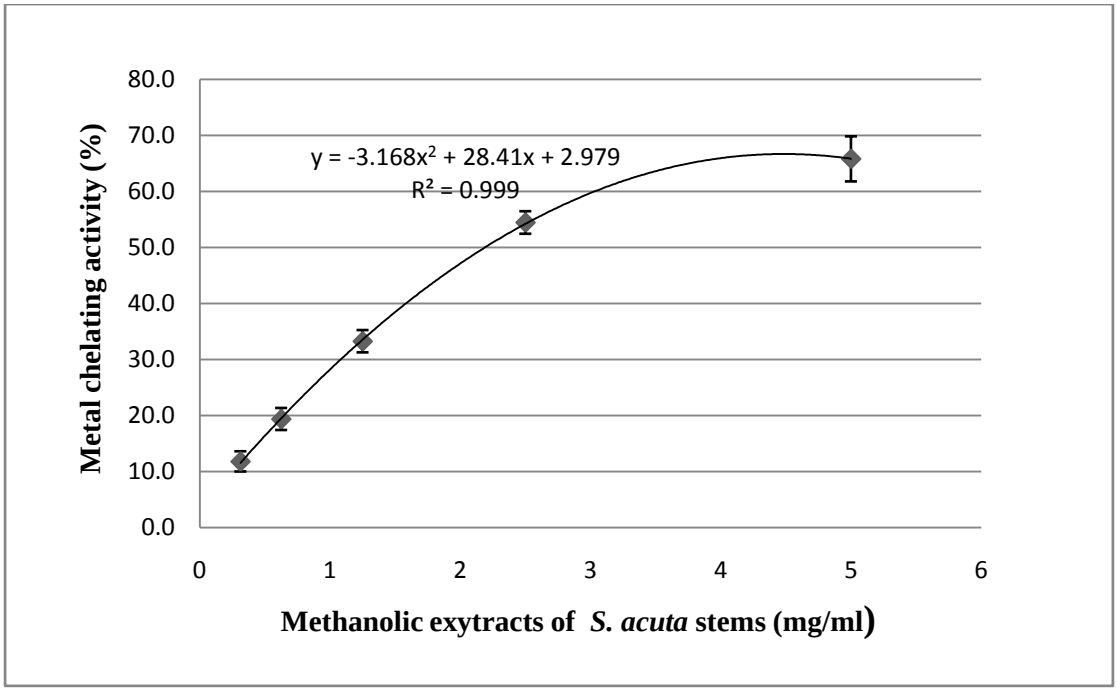


Figure 98 Metal chelating activity of methanolic extracts of *S. acuta* stems

Table 108 Metal chelating activity of EDTA

Quercetin (mg/ml)	OD_{405} (reaction mixture)			Nitric oxide scavenging (%)				
	exp 1	exp 2	exp 3	exp 1	exp 2	exp 3	Mean	SD
0.00	0.5948	0.6016	0.5716					
0.07	0.4411	0.4082	0.3621	8.7	8.2	11.2	9.4	1.6
0.09	0.4021	0.3721	0.3311	17.7	16.5	19.4	17.9	1.4
0.11	0.3322	0.3043	0.3012	35.3	35.1	32.2	34.2	1.8
0.13	0.2866	0.2628	0.2549	49.5	49.9	47.7	49.0	1.2
0.15	0.2446	0.1934	0.1996	59.1	68.1	66.2	64.5	4.7
0.17	0.1954	0.1969	0.1756	78.6	73.9	74.3	75.6	2.6
0.19	0.1639	0.1455	0.1585	86.4	89.9	84.9	87.1	2.5
0.21	0.1246	0.1034	0.1096	95.9	100.8	94.2	97.0	3.4

Quercetin (mg/ml)	OD_{405} (blank)		
	exp 1	exp 2	exp 3
0.00	0.1349	0.1822	0.1854
0.07	0.0211	0.0232	0.0192
0.09	0.0234	0.0221	0.0199
0.11	0.0345	0.0322	0.0392
0.13	0.0544	0.0525	0.0529
0.15	0.0567	0.0596	0.0692
0.17	0.0968	0.0875	0.0765
0.19	0.1015	0.1031	0.1003
0.21	0.1057	0.1069	0.0872

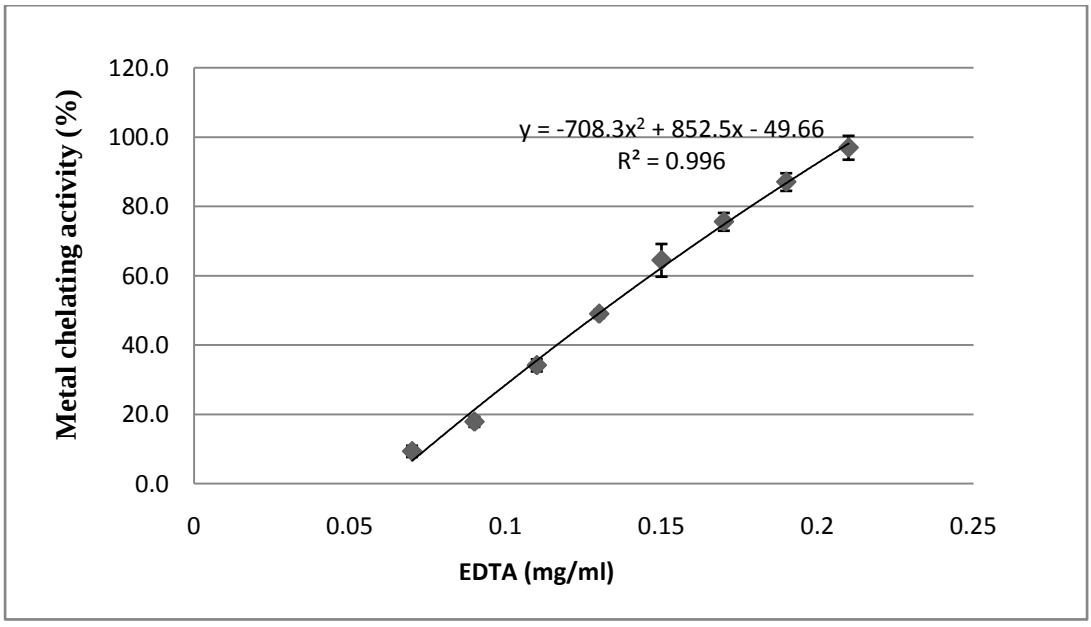


Figure 99 Metal chelating activity of EDTA

Table 109 The absorbance of reducing power capacity of *S. acuta* extracts

Solvent extract	Plant material	Absorbance at 700 nm			Mean±SD
		1	2	3	
Dichloromethane	Stems	0.273	0.265	0.3	0.28±0.02
	Roots	0.395	0.353	0.209	0.32±0.10
	Leaves	0.899	0.918	0.893	0.90±0.01
Methanolic	Stems	0.213	0.355	0.249	0.27±0.07
	Roots	0.322	0.241	0.197	0.25±0.06
	Leaves	0.543	0.778	0.635	0.65±0.12
BHT		1.125	0.987	1.09	1.07±0.07
Quercetin		1.821	1.752	0.964	1.51±0.48

Table110 Number of survivor naupli at each time among various concentrations of *S. acuta* extracts

Solvent	Plant material	Concentrations (µg/ml)	6					Mean	18					Mean	24					Mean	%Lethality
			1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		
Dichloromethane	Stems	9000	0	0	0	0	0	0	3	2	1	1	1	1.6	7	7	6	4	4	5.6	56
		7000	0	0	0	0	0	0	2	0	3	1	1	1.4	6	5	4	4	2	4.2	42
		5000	0	0	0	0	0	0	1	1	1	0	2	1	4	3	4	3	4	3.6	36
		3000	0	0	0	0	0	0	1	0	1	1	1	0.8	4	5	3	2	2	3.2	32
		1000	0	0	0	1	0	0.2	0	2	1	0	0	0.6	4	4	2	3	2	3	30
	Roots	9000	1	1	2	0	0	0.8	3	0	0	1	1	1	7	7	5	5	5	5.8	58
		7000	1	1	1	0	0	0.6	2	0	0	0	1	0.6	5	7	5	3	2	4.4	44
		5000	1	1	1	0	0	0.6	0	1	0	2	0	0.6	6	4	4	3	4	4.2	42
		3000	2	0	0	0	0	0.4	0	0	0	0	2	0.4	3	6	3	2	3	3.4	34
		1000	0	1	0	0	0	0.2	0	0	0	0	1	0.2	3	3	3	5	2	3.2	32
	Leaves	9000	1	1	2	0	0	0.8	3	2	4	1	1	2.2	6	6	5	4	4	5	50
		7000	1	1	1	1	0	0.8	2	2	3	1	1	1.8	5	6	5	5	2	4.6	46
		5000	2	1	0	0	0	0.6	4	1	1	0	2	1.6	4	3	4	3	4	3.6	36
		3000	0	1	0	2	0	0.6	2	1	1	1	1	1.2	3	5	3	2	2	3	30
		1000	0	0	0	1	0	0.2	0	2	1	1	1	1	3	3	3	3	2	2.8	28

Table 111(cont) Number of survivor naupli at each time among various concentrations of *S. acuta* extracts

Solvent	Plant material	Concentrations (µg/ml)	6					Mean	18					Mean	24					Mean	%Lethality
			1	2	3	4	5		1	2	3	4	5		1	2	3	4	5		
Methanolic	Stems	9000	0	0	0	0	0	0	5	4	2	3	4	3.6	6	6	5	4	7	5.6	56
		7000	0	0	0	0	0	0	5	3	1	2	3	2.8	8	4	6	5	4	5.4	54
		5000	0	0	0	0	0	0	4	2	1	2	2	2.2	6	6	4	3	7	5.2	52
		4000	0	0	0	0	0	0	2	2	1	2	2	1.8	3	5	5	5	7	5	50
		3000	0	0	0	0	0	0	1	1	0	2	0	0.8	7	6	5	4	2	4.8	48
		2000	0	0	0	0	0	0	0	0	0	1	0	0.2	4	5	4	4	5	4.4	44
		1000	0	0	0	0	0	0	0	0	0	0	0	0	6	3	6	3	2	4	40
	Roots	9000	0	0	0	0	0	0	4	4	6	3	5	4.4	5	5	5	5	6	5.2	52
		7000	0	0	0	0	0	0	2	4	3	4	4	3.4	5	4	5	4	5	4.6	46
		5000	0	0	0	0	0	0	2	3	2	4	3	2.8	5	4	5	5	4	4.6	46
		3000	0	0	0	0	0	0	3	3	1	3	2	2.4	5	4	5	3	1	3.6	36
		1000	0	0	0	0	0	0	1	2	1	1	1	1.2	4	3	2	2	2	2.6	26
	Leaves	9000	1	0	1	1	1	0.8	4	5	4	4	5	4.4	5	5	4	7	5	5.2	52
		7000	1	1	1	1	0	0.8	2	2	5	5	5	3.8	4	4	5	6	6	5	50
		5000	0	3	0	0	0	0.6	3	6	3	2	2	3.2	4	6	4	5	5	4.8	48
		4000	1	0	0	1	1	0.6	3	6	2	1	2	2.8	3	7	3	2	4	3.8	38
		3000	0	0	0	1	0	0.2	2	5	0	1	1	1.8	3	3	2	5	4	3.4	34
		2000	0	0	0	2	0	0.4	1	3	2	2	1	1.8	2	5	3	2	3	3	30
		1000	0	1	0	0	0	0.2	1	2	1	0	0	0.8	2	3	1	5	3	2.8	28

VITAE

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Proceedings

Dinlakanont, N., Chaijaroenkul, W., Palanuvej, C. and Ruangrungsi, N. *In Vitro* bioassays of a Thai Medicinal plant *Sida acuta* BURM. F. Proceeding of The 38th Congress on science and technology of Thailand, Chiang mai, 2012

Dinlakanont, N., Chaijaroenkul, W., Palanuvej, C. and Ruangrungsi, N. *In vitro* bioassays of methanolic extracts of *Sida acut*a Burm.F. Proceeding of The 1st International Conference on Herbal Medicines Herbal Remedies: The art of Science, pp. 78-82. Pathumthani, 2012