CHAPTER V

CONCLUSION and SUGGESTION

The investigation on the chemical modification of native Cassava starch by a graft copolymerization has led to a new type of polymer with attractive water absorption properties. This novel material is a biodegradable high water-absorbing polymer. The results obtained are very significant in terms of the numerous applications possible. The product had already been used in agricultural, horticultural, silviculture areas and in industrial goods such as sanitary napkins, baby diapers, etc. The results in this experiment match well similar materials, synthesized from different sources of substrate by the other methods, in industrial countries.

5.1 <u>Conclusion</u>

The chemical characteristics of this novel material can be summarized as follows:-

5.1.1 Cassava starch-g-PAN was synthesized and confirmed by infrared spectroscopy. The nitrile stretching band appeared at 2,243 cm^{-1}during grafting and dissappeared during saponification; the characteristic bands appeared at 3,400; 1,000-1,100 cm^{-1}indicated the occurance of grafting of Cassava starch. The dissappearance of all the nitrile groups, on the other hand, resulted in the appearance of carboxylate and carboxamide groups. The formation of two new functional groups resulted also in two new absorption bands. Firstly, the carboxylate group -COOK gave rise to two bands: a strong asymmetrical stretching band at 1,570 cm^{-1}, and a weak, symmetrical stretching band at 1,400 cm^{-1}. Secondly, the primary amide could not be detected, probably as a result of a relatively low concentration, and/or due to the usually low intensity of the NH stretching band and overlapping with existing ones, the OH stretching bands of the starting material. These two groups are capable of water absorption properties based on the differential in osmotic pressure due to the potassium carboxylate and carboxamide semipermeable membrane (62).

5.1.2 As a general rule of graft copolymerization, homopolymer formation usually accompanies grafting reaction. It is neccessary to suppress the formation of homopolymer, several homopolymer suppressors are used: cupric sulphate, lead nitrate, aluminium nitrate, and a thin slice of aluminium foil. The result indicated that the aluminium foil is one of the best suppressors for homopolymer.

5.1.3 By increasing the quantities of total dose, increase in percentage homopolymer and grafting frequency at the total dose other than 2.529 kgy was observed; likewise, the percent add-on, the percent grafting efficiency, the percent grafting ratio, and the water retention value at the total dose other than 2.519 kgy decreased. The molecular weight average($\bar{M}_v$) and the percent conversion of monomer increased with increasing the total dose. Water absorption capacity of Cassava starch-g-PAN synthesized was in the range of 83 to 235 times their origin dried weight depending upon the quantities of total dose, based on a 1:1 ratio of the starch(g) and AN(ml).

5.1.4 By increasing the quantities of the irradiation dose rate, decreases in the percent add-on, the percent conversion of monomer, the grafting ratio, the molecular weight average ($\bar{M}_v$) of grafted PAN, and the grafting efficiency were observed, while the percent homopolymer formation increased. The water retention of saponified starch-g-polyacrylonitrile was in the range 175 to 445 times their dried weight depending upon the dose rate of gamma radiations, based on a 1:1 of the starch(g) and AN(ml). The reaction mixture was exposed to gamma rays with the fixed total dose at 2.529 kgy. According to these investigations, the Cassava starch-g-polyacrylonitrile with high water absorption capacity can be obtained by exposing to gamma rays at the dose rate of 18.80 gray/min.

5.1.5 By increasing the acrylonitrile content, an increase of the percent homopolymer formed, the percent add-on, the grafting ratio, and the molecular weight ($\bar{M}_v$) of grafted PAN was observed. The grafting frequency was in the range of 727 to 1,303 AGU/chain. The water retention capacity of saponified starch-g-polyacrylonitrile was in the range of 31 to 665 times their original dried weight depending on the AN content from 5 to 40 ml based on 10 g of Cassava starch. The reactions were carried out with the irradiation dose at 2.529 kgy and a dose rate of 18.80 gray/min. The starch/acrylonitrile ratio of 10:15 is an attractive figure since it is economical to produce in term of the amount of homopolymer formation and not too high viscosity, yet still gives the highest water absorption value of 665.

5.1.6 Water absorption capacity of saponified graft copolymer in 0.1, 0.5, 1.0, and 2.0 % w/v of sodium chloride solutions was maximum at 148.6, 103.0, 68.3, and 57.0 g/g respectively. An increase in ion content in water, reduces the water absorption due to a decrease in the osmotic pressure.

5.1.7 Water absorption capacity of saponified graft copolymer in 0.1, 0.5, 1.0, and 2.0 % w/v of magnesium chloride solutions was maximum at 123.1, 32.1, 29.4, and 25.9 g/g respectively. At the same concentration, magnesium chloride solutions have a lower absorption value than those of sodium chloride solutions. This suggests that the osmotic pressure equilibrium was reached earlier in the presence of the divalent ion.

5.1.8 Water absorption capacity of $K_3PO_4.3H_2O$, KCl, NH_4Cl, and $(NH_4)_2HPO_4$ solutions at the same concentration of 0.9% w/w were maximum at 91.8, 93.7, 77.2, and 91.4 g/g respectively.

5.1.9 Water retention capacity in sand was 0.3 g/g. Mixtures of sand with 0.5, 1.0, 2.0 and 3.0 % of saponified starch-g-polyacrylonitrile could increase water retention gradually upto a maximum value of 306.3 g/g at 3.0 % of the saponified polymer synthesized from 40 ml of acrylonitrile.

5.2 Suggestion and Future Work

Two irradiation techniques on the mixture of Cassava starch and acrylonitrile can be used to synthesize a new type of high water - absorbing polymer. The current synthesized technique is the simultaneous method; to develop an even better and new high water-absorbing polymers to be used in agriculture and other applications, futher work should be carried out as follows.

5.2.1 The preirradiation technique is worth carrying out to synthesis the starch-g-polyacrylonitrile, as this technique has an inherent merit in reducing the amount of homopolymer which theoretically increase the extent of grafting reaction, a governing factor of water absorption.

5.2.2 Utmost efforts should be pursued to develop a technique for more stable starch-based high water absorbing polymer under severe conditions of daily application.

5.2.3 Instead of using acrylonitrile as a grafting monomer, acrylic acid, and/or methyl methacrylate could also be used.

5.2.4 Improve gel strength of the saponified grafted copolymer by using a very mild crosslinking agent.

5.2.5 Study the influence of crosslinking density on the water absorption capacity.