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APPENDICES

APPENDIX I

DETAILS OF POLYMERS AND PLASTICIZERS

Ethylcellulose

Ethylcellulose is an ethyl ether of cellulose. It is a long-chain polymer consisting of anhydroglucose units joined together by acetal linkages. Each anhydroglucose unit has three replaceable hydroxyl groups which are substituted to the extent of 2.25-2.60 ethoxyl groups (OC_2H_5) per unit, equivalent to an ethoxyl content of 44-51% (Kibbe A.H., 2000)

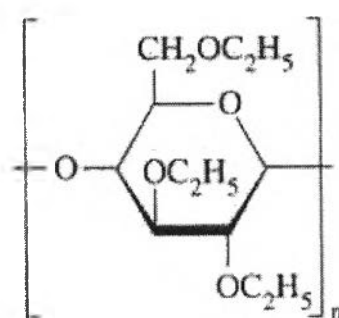


Figure 34. Structural formula of ethylcellulose (Kibbe A.H., 2000).

Ethylcellulose resins are tasteless, odorless, nonionic charge, free-flowing, white to light-tan granular powders. The differences in physical properties of the ethylcellulose products result largely from variation in the degree of etherification.

Properties of Ethylcellulose

Density (bulk): 0.4 g/cm.

Glass transition temperature: 130-133°C

Hygroscopicity: Ethylcellulose absorbs very little water at high relative humidity or during immersion; any absorbed water evaporates readily.

Solubility: Ethylcellulose is practically insoluble in hexanes, glycerin, propylene glycol and water. Ethylcellulose that contains less than 46.5% of ethoxy groups is freely soluble in chloroform, methyl acetate, tetrahydrofuran, and in mixtures of aromatic hydrocarbons with ethanol (95%). Ethylcellulose that contain not less than 46.5% of ethoxyl groups is freely soluble in chloroform, ethanol (95%), ethyl acetate, methanol, and toluene.

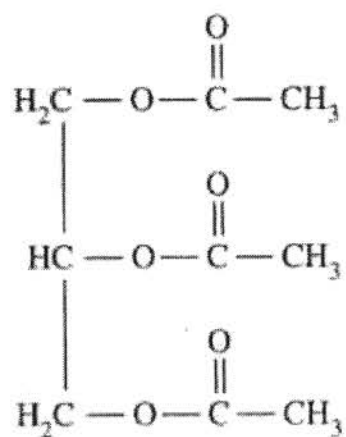
Specific gravity: 1.12-1.15

Viscosity: Various grades of ethylcellulose are commercially available which differ in their ethoxyl content and degree of polymerization. They may be used to produce 5%w/v solutions in organic solvents with viscosities of 6-110 mPas (cP). The viscosity of solutions increases with an increase in concentration of ethylcellulose and as the length of the polymer molecule increases.

Stability: Ethylcellulose is a stable, slightly hygroscopic material. It is chemically resistant to alkalis, both dilute and concentrated, and to salt solutions, although it is more sensitive to acidic materials than cellulose esters. Ethylcellulose is subject to oxidative degradation in the presence of sunlight or UV light at elevated temperatures but light, visible or UV, has no discoloring action on ethylcellulose.

Incompatibility: Ethylcellulose is incompatible with paraffin wax and microcrystalline wax.

Glycerol Triacetate



MW: 218.21

Figure 35. Structural formula of glycerol triacetate (Kibbe A.H., 2000).

Glycerol triacetate is a colorless, viscous liquid with a slightly fatty odor. It is used as a hydrophilic plasticizer in both aqueous and solvent-based polymeric coating of capsules, tablets, beads, and granules; typical concentration used are 10-35%w/w.

it is also reported to possess fungistatic properties due to the liberation of acetic acid and has been used as a 25%w/w cream or ointment in the treatment of superficial fungal conditions. In addition, it is used in cosmetics, perfumery and foods as a solvent and as a fixative in the formulation of perfumes and flavors.

Properties of Glycerol Triacetate

Boiling point: 258°C

Melting point: -78°C

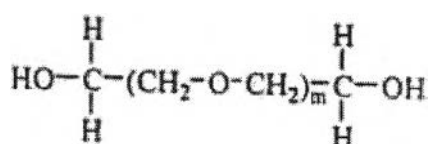
Density: 1.16 g/cm³ at 25°C

Solubility: Glycerol triacetate miscible with chloroform, ethanol (95%), and ether. It is soluble 1 in 14 of water.

Stability: Glycerol triacetate is stable and should be stored in a well-closed, nonmetallic container, in a cool and dry place.

Incompatibility: Glycerol triacetate is incompatible with metals and may react with oxidizing agents.

Polyethylene Glycol



MW (PEG400): 380-420

Figure 36. Structural formula of polyethylene glycol (Kibbe A.H., 2000).

The USP describes polyethylene glycol as being an addition polymer of ethylene oxide and water. Polyethylene glycol grades 200-600 are liquids; grades 1000 and above are solids at ambient temperature.

Liquid grades (PEG 200-600) occur as clear, colorless or slightly yellow-colored, viscous liquid. They have a slight, but characteristic odor and a bitter, slightly burning taste. PEG 600 can occur as a solid at ambient temperatures.

Solid grades (PEG>1000) are white or off-white in color, and range in consistency from pastes to waxy flakes. They have a faint, sweet odor. Grades of PEG 6000 and above are available as free-flowing milled powders.

Properties of Polyethylene Glycol

Density: 1.11-1.14 g/cm³ at 25°C for liquid PEGs;
1.11-1.14 g/cm³ at 25°C for liquid PEGs.

Flash point: 182°C for PEG 200;
213°C for PEG 300;
238°C for PEG 400;
250°C for PEG 600.

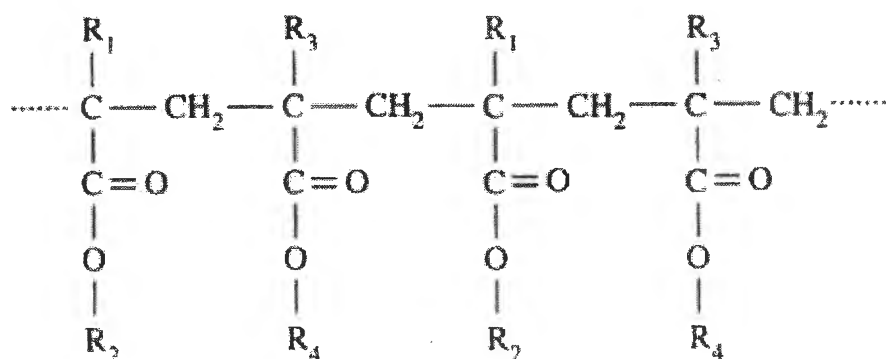
Moisture content: Liquid PEGs are vary hygroscopic, although hygroscopicity decreases with increasing molecular weight.

Solubility: All grades of PEG are soluble in water and miscible in all proportions with other PEGs (after melting, if necessary). Aqueous solutions of higher molecular weight grades may form gels. Liquid PEGs are soluble in acetone, alcohol, benzene, glycerin, and glycols. Solid PEGs are soluble in acetone, dichloromethane, ethanol, and methanol; they are slightly soluble in aliphatic hydrocarbons and ether, but insoluble in fats, fixed oils, and mineral oil.

Stability: PEGs are chemically stable in air and in solution although grades with a molecular weight less than 2000 are hygroscopic. PEGs do not support microbial growth, nor do they become rancid.

Incompatibility: The chemical reactivity of PEGs is mainly confined to the two terminal hydroxyl groups, which can be either esterified or etherified. However, all grades can exhibit some oxidizing activity due to the presence of peroxide impurities and secondary products formed by autoxidation.

Polymethacrylate



MW: $\geq 100,000$

Figure 37. Structural formular of polymethacrylate (Kibbe A.H., 2000).

Polymethacrylates are synthetic cationic and anionic polymers of dimethylaminoethylmethacrylates, methacrylic acid, and methacrylic acid esters in varying ratios. Several different types are commercially available and may be obtained as the dry powder, an aqueous dispersion, or as an organic solution. A (60:40) mixture of acetone and propan-2-ol is most commonly used as the organic solvent.

Properties of Polymethacrylate

Density (bulk): 0.390 g/cm^3

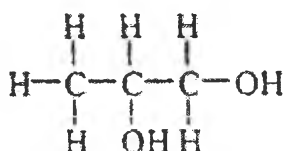
Density (tapped): 0.424 g/cm^3

Stability: Dry powder polymer forms are stable at temperatures less than 30°C . Above this temperature, powders tend to form clumps although this does not affect the quality of the substance and the clumps can be readily broken up. Dry powders are stable for at least three years if stored in a tightly closed container at less than 30°C . Dispersions are sensitive to extreme temperatures and phase separation occurs below 0°C . Dispersions should also be stored at temperatures between $5\text{-}25^\circ\text{C}$ and are stable

for at least 18 months after shipping from the manufacturer's warehouse if stored in a tightly closed container at the above conditions.

Incompatibility: Incompatibilities occur with certain polymethacrylate dispersions depending on the ionic and physical properties of the polymer and solvent. For example, coagulation may be caused by soluble electrolytes, pH changes, some organic solvent, and extremes of temperature.

Propylene Glycol



MW: 76.1

Figure 38. Structural formula of propylene glycol (Kibbe A.H., 2000).

Propylene glycol is a clear, colorless, viscous, practically, odorless liquid with a sweet, slightly acid taste resembling glycerin.

Properties of Propylene Glycol

Boiling point: 188°C

Density: 1.038 g/cm³ at 20°C

Melting point: -59°C

Solubility: miscible with acetone, chloroform, ethanol (95%), glycerin, and water; soluble 1 in 6 parts of ether; not miscible with light mineral oil, but will dissolve some essential oil.

Stability: At cool temperatures, propylene glycol is stable in a well-closed container, but at high temperatures, in the open, it tends to oxidize, giving rise to products such as propionaldehyde, lactic acid, pyruvic acid, and acetic acid. Propylene glycol is chemically stable when mixed with ethanol (95%), glycerin, or water; aqueous

solutions may be sterilized by autoclaving. Propylene glycol is hygroscopic and should be stored in a well-closed container, protected from light, in a cool, dry, place.

Incompatibility: Propylene glycol is incompatible with oxidizing reagents such as potassium permanganate.



APPENDIX II

ANALYTICAL DETERMINATION OF CURCUMINOIDS IN CURCUMINOID MICROCAPSULES

Analytical Determination of Curcuminoids in Curcuminoid Microcapsules

Chemicals

1. Acetonitrile, HPLC grade (Lab scan)
2. Methanol, AR grade (Lab scan)

Equipments

1. HPLC (Shimadzu) 10ADvp class
2. Colume: C18 column, Inersil ODS 5 micron 4.6 mm x 150 mm (GL Science, Japan) with a guard column, Inersil ODS 5 micron 4.6 mm x 150 mm (GL Science, Japan)

HPLC Conditions

HPLC column:	C18 column, Inersil ODS 5 micron 4.6 mm x 150 mm
Mobile phase:	2% acetic acid: acetonitrile (60: 40)
Flow rate:	2.0 mL/min
Injection volumn:	20 μ L
Detector wavelength:	425 nm
Temperature:	ambient temperature
Run Time:	19 min
Rt of Bisdesmethoxycurcumin	13.352 min
Rt of Desmethoxycurcumin	14.823 min
Rt of Curcumin	16.452 min

Determination of Curcuminoids Content in Microcapsules at Month 0

Preparation of Curcuminoids Working Standard Solution

Standard Stock Preparation

Working std	10 mg	$\xrightarrow{\text{MeOH}}$	10 mL
	100 μL	$\xrightarrow{\text{Mobile Phase}}$	10 mL

Standard Curve Preparation

std stock solution	100 μL	$\xrightarrow{\text{Mobile Phase}}$	1000 μL
std stock solution	250 μL	$\xrightarrow{\text{Mobile Phase}}$	1000 μL
std stock solution	500 μL	$\xrightarrow{\text{Mobile Phase}}$	1000 μL
std stock solution	750 μL	$\xrightarrow{\text{Mobile Phase}}$	1000 μL
std stock solution	1000 μL		

Preparation of Sample Solutions

Sample	10 mg	$\xrightarrow{\text{MeOH}}$	10 mL
	100 μL	$\xrightarrow{\text{Mobile Phase}}$	10 mL (conc. 10 $\mu\text{g}/\text{ml}$)

Table 31. Peak area, curcuminoids concentration, and percent curcuminoids content of curcumin, desmethoxycurcumin, and bisdesmethoxycurcumin at month 0.

No.	Microcapsules conc. ($\mu\text{g/ml}$)	Bisdesmethoxy curcumin			Desmethoxy curcumin		
		PA	Conc. ($\mu\text{g/ml}$)	% Content	PA	Conc. ($\mu\text{g/ml}$)	% Content
7	10.099	6853	0.120	1.19	31388	0.891	8.83
8	9.802	5741	0.102	1.04	26069	0.749	7.64
9	19.604	6579	0.116	0.59	25393	0.731	3.73
10	19.604	6383	0.113	0.57	26991	0.773	3.95
11	19.802	5473	0.098	0.49	23973	0.693	3.50
12	19.802	3936	0.073	0.37	17036	0.507	2.56
13	10.099	4805	0.087	0.86	21716	0.632	6.26
14	9.802	3491	0.066	0.67	14493	0.439	4.47
15	19.802	7160	0.125	0.63	28403	0.811	4.10
16	20.000	6308	0.111	0.56	26181	0.752	3.76
17	19.802	3718	0.069	0.35	17357	0.515	2.60
18	20.000	4793	0.087	0.43	17391	0.516	2.58
37	9.901	7178	0.126	1.27	34104	0.964	9.74
38	10.099	6437	0.113	1.12	29655	0.845	8.37
39	19.604	5657	0.101	0.51	22398	0.650	3.32
40	19.604	8322	0.144	0.73	33825	0.957	4.88
41	19.406	4444	0.081	0.42	20463	0.599	3.08
42	19.604	3458	0.065	0.33	15040	0.453	2.31
43	10.000	10716	0.183	1.83	45383	1.266	12.66
44	10.099	8357	0.145	1.43	38373	1.078	10.68
45	20.000	14786	0.249	1.25	60013	1.658	8.29
46	19.604	13119	0.222	1.13	50545	1.405	7.17
47	20.000	9202	0.158	0.79	35754	1.008	5.04
48	20.594	11482	0.195	0.95	44276	1.237	6.01
49	9.901	10173	0.174	1.76	39964	1.121	11.32
50	9.901	7229	0.126	1.28	30743	0.874	8.83
51	19.406	7474	0.130	0.67	30587	0.870	4.48
52	19.604	6870	0.121	0.61	28581	0.816	4.16
53	19.802	5933	0.105	0.53	21358	0.623	3.14
54	19.406	4715	0.086	0.44	19661	0.577	2.97

Table 31. (Continued)

No.	Microcapsules conc. ($\mu\text{g/ml}$)	Curcumin			Total curcuminoid	
		PA	Conc. ($\mu\text{g/ml}$)	% Content	Conc. ($\mu\text{g/ml}$)	% Content
7	10.10	114834	2.753	27.26	3.764	37.27
8	9.80	96508	2.335	23.82	3.186	32.50
9	19.60	93027	2.256	11.51	3.102	15.82
10	19.60	94486	2.289	11.68	3.175	16.20
11	19.80	86296	2.103	10.62	2.893	14.61
12	19.80	63424	1.582	7.99	2.161	10.91
13	10.10	83449	2.038	20.18	2.757	27.30
14	9.80	54268	1.373	14.01	1.877	19.15
15	19.80	102847	2.480	12.52	3.416	17.25
16	20.00	92153	2.236	11.18	3.099	15.50
17	19.80	61059	1.528	7.71	2.112	10.67
18	20.00	74987	1.845	9.22	2.448	12.24
37	9.90	128283	3.059	30.90	4.149	41.90
38	10.10	112586	2.701	26.75	3.660	36.24
39	19.60	78507	1.925	9.82	2.676	13.65
40	19.60	118441	2.835	14.46	3.935	20.07
41	19.41	73031	1.800	9.28	2.480	12.78
42	19.60	49913	1.274	6.50	1.792	9.14
43	10.00	165665	3.910	39.10	5.360	53.60
44	10.10	138204	3.285	32.53	4.508	44.64
45	20.00	216023	5.058	25.29	6.965	34.82
46	19.60	174838	4.119	21.01	5.746	29.31
47	20.00	124876	2.981	14.91	4.148	20.74
48	20.59	156685	3.706	17.99	5.138	24.95
49	9.90	146239	3.468	35.03	4.763	48.11
50	9.90	112631	2.702	27.29	3.703	37.40
51	19.41	105146	2.532	13.05	3.532	18.20
52	19.60	103048	2.484	12.67	3.421	17.45
53	19.80	73997	1.822	9.20	2.550	12.88
54	19.41	65617	1.631	8.41	2.294	11.82

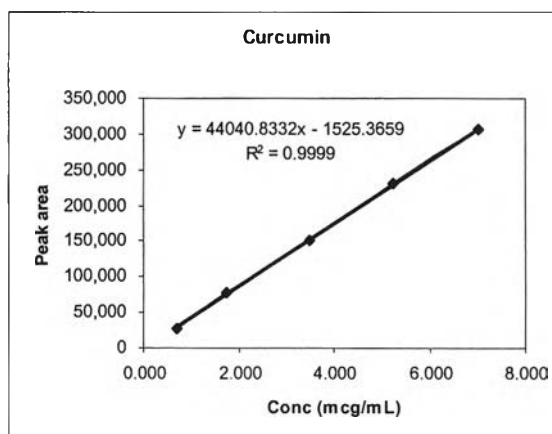
Determination of Curcuminoids Content in Microcapsules at Month 1

Figure 39. Standard curve of curcumin for month 1.

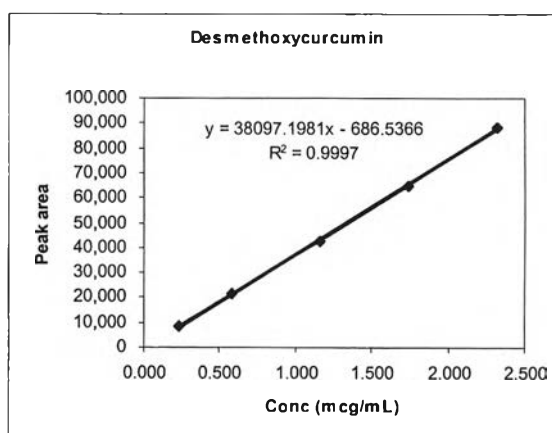


Figure 40. Standard curve of desmethoxycurcumin for month 1.

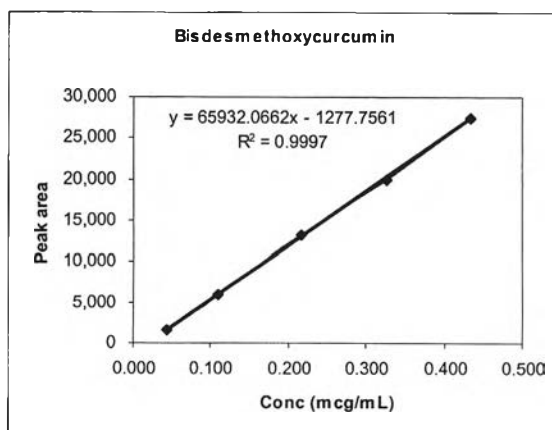


Figure 41. Standard curve of bisdesmethoxycurcumin for month 1.

Table 32. Peak area, curcuminoids concentration, and percent curcuminoids content of curcumin, desmethoxycurcumin, and bisdesmethoxycurcumin at month 1.

storage temp	sample no.	microcapsules conc. ($\mu\text{g/ml}$)	Bisdesmethoxycurcumin			Desmethoxycurcumin		
			PA	Conc. ($\mu\text{g/ml}$)	% Content	PA	Conc. ($\mu\text{g/ml}$)	% Content
4C	7.1	9.109	5918	0.109	1.20	30290	0.813	8.93
	7.2	9.802	7303	0.130	1.33	34523	0.924	9.43
	13.1	9.901	5447	0.097	0.98	24797	0.715	7.22
	13.2	9.901	5741	0.106	1.08	26544	0.715	7.22
	37.1	9.901	8224	0.144	1.46	38945	1.040	10.51
	37.2	9.802	7959	0.140	1.43	38346	1.025	10.45
	43.1	10.000	11418	0.193	1.93	51799	1.378	13.78
	43.2	10.297	13335	0.222	2.15	59363	1.576	15.31
	49.1	9.604	8524	0.147	1.53	33735	0.954	9.94
	49.2	10.297	9003	0.156	1.51	44365	1.183	11.48
RT	7.1	9.505	8235	0.144	1.52	35025	0.937	9.86
	7.2	10.099	7973	0.140	1.39	35166	0.941	9.32
	13.1	10.099	6937	0.122	1.20	29020	0.828	8.20
	13.2	9.703	7447	0.132	1.36	31454	0.844	8.69
	37.1	9.703	8258	0.143	1.47	39446	1.107	11.41
	37.2	9.802	8071	0.142	1.45	39395	1.052	10.73
	43.1	10.099	10392	0.178	1.76	46395	1.293	12.81
	43.2	9.703	10910	0.185	1.91	50307	1.339	13.79
	49.1	10.000	9775	0.168	1.68	41627	1.166	11.66
	49.2	9.802	9883	0.169	1.73	44594	1.189	12.13
40C	7.1	9.703	7895	0.137	1.41	34319	0.970	10.00
	7.2	9.901	8896	0.154	1.56	36463	0.975	9.85
	13.1	9.604	6421	0.113	1.18	26599	0.763	7.94
	13.2	9.802	6604	0.120	1.22	27577	0.742	7.57
	37.1	10.099	9272	0.160	1.58	40138	1.126	11.15
	37.2	9.901	8568	0.149	1.51	37703	1.008	10.18
	43.1	10.198	9969	0.171	1.68	44699	1.248	12.24
	43.2	10.297	10242	0.175	1.70	49319	1.313	12.75
	49.1	9.703	9025	0.155	1.60	44436	1.241	12.79
	49.2	10.099	9133	0.158	1.56	43667	1.164	11.53
50C	7.1	9.604	8425	0.146	1.52	34883	0.985	10.26
	7.2	9.901	8036	0.141	1.43	33801	0.905	9.14
	13.1	10.000	7798	0.138	1.38	34814	0.932	9.32
	13.2	9.901	7603	0.135	1.36	34007	0.911	9.20
	37.1	10.099	9056	0.156	1.54	43013	1.203	11.91
	37.2	10.099	10720	0.182	1.80	46186	1.230	12.18
	43.1	9.802	11403	0.194	1.98	47552	1.324	13.51
	43.2	9.802	11768	0.198	2.02	52043	1.384	14.12
	49.1	9.703	7771	0.135	1.39	35054	0.990	10.20
	49.2	9.901	9676	0.166	1.68	43974	1.172	11.84

Table 32. (Continued)

storage temp	sample no.	microcapsules conc.($\mu\text{g/ml}$)	Curcumin			Total curcuminoid	
			PA	Conc. ($\mu\text{g/ml}$)	% Content	Conc. ($\mu\text{g/ml}$)	% Content
4C	7.1	9.109	109234	2.515	27.61	3.437	37.73
	7.2	9.802	125853	2.892	29.51	3.947	40.26
	13.1	9.901	89045	2.165	21.87	2.977	30.07
	13.2	9.901	94654	2.184	22.06	3.005	30.35
	37.1	9.901	137671	3.161	31.92	4.345	43.88
	37.2	9.802	135844	3.119	31.82	4.284	43.70
	43.1	10.000	182928	4.188	41.88	5.758	57.58
	43.2	10.297	214893	4.914	47.72	6.712	65.18
	49.1	9.604	124920	2.982	31.05	4.084	42.52
	49.2	10.297	158142	3.625	35.21	4.964	48.21
RT	7.1	9.505	121736	2.799	29.45	3.880	40.83
	7.2	10.099	127462	2.929	29.00	4.010	39.71
	13.1	10.099	109249	2.625	26.00	3.575	35.40
	13.2	9.703	110502	2.544	26.22	3.520	36.27
	37.1	9.703	145197	3.444	35.50	4.695	48.38
	37.2	9.802	141913	3.257	33.23	4.451	45.41
	43.1	10.099	172117	4.057	40.18	5.529	54.74
	43.2	9.703	181682	4.160	42.87	5.683	58.57
	49.1	10.000	153794	3.640	36.40	4.973	49.73
	49.2	9.802	160006	3.668	37.42	5.026	51.27
40C	7.1	9.703	125837	3.003	30.95	4.110	42.36
	7.2	9.901	129710	2.980	30.10	4.109	41.50
	13.1	9.604	100529	2.427	25.27	3.303	34.39
	13.2	9.802	99666	2.298	23.44	3.159	32.23
	37.1	10.099	147881	3.505	34.71	4.791	47.44
	37.2	9.901	134068	3.079	31.10	4.236	42.78
	43.1	10.198	191989	4.510	44.22	5.929	58.14
	43.2	10.297	195228	4.468	43.39	5.955	57.83
	49.1	9.703	151823	3.595	37.05	4.992	51.44
	49.2	10.099	159027	3.646	36.10	4.968	49.19
50C	7.1	9.604	126831	3.026	31.51	4.157	43.28
	7.2	9.901	120978	2.782	28.09	3.828	38.66
	13.1	10.000	122469	2.815	28.15	3.885	38.85
	13.2	9.901	119310	2.744	27.71	3.789	38.27
	37.1	10.099	156928	3.711	36.75	5.070	50.21
	37.2	10.099	165621	3.795	37.58	5.208	51.57
	43.1	9.802	177350	4.177	42.61	5.695	58.10
	43.2	9.802	186602	4.272	43.58	5.854	59.72
	49.1	9.703	127441	3.040	31.33	4.164	42.92
	49.2	9.901	161343	3.698	37.35	5.037	50.87

Determination of Curcuminoids Content in Microcapsules at Month 2

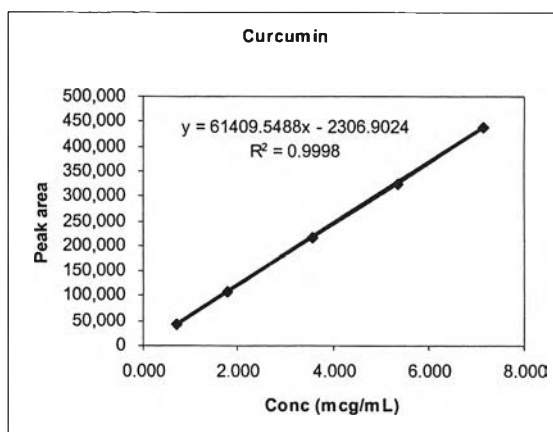


Figure 42. Standard curve of curcumin for month 2.

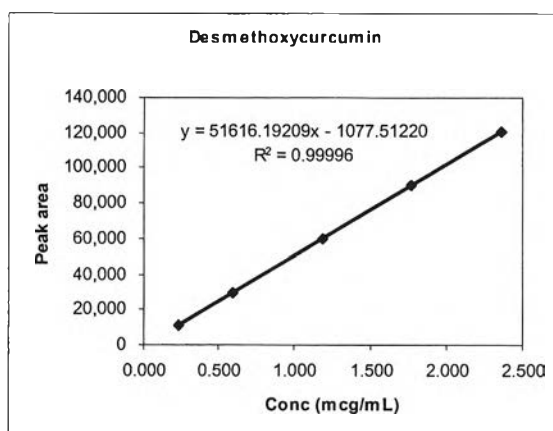


Figure 43. Standard curve of desmethoxycurcumin for month 2.

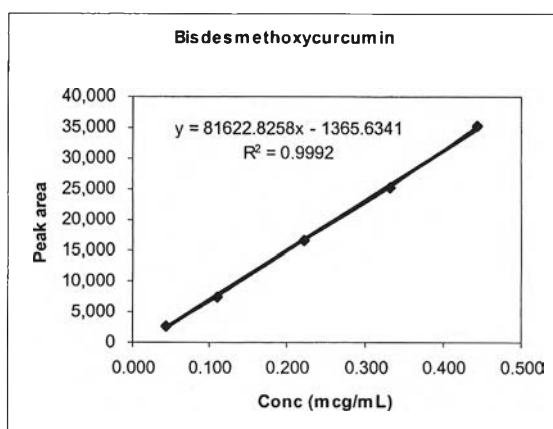


Figure 44. Standard curve of bisdesmethoxycurcumin for month 2.

Table 33. Peak area, curcuminoids concentration, and percent curcuminoids content of curcumin, desmethoxycurcumin, and bisdesmethoxycurcumin at month 2.

Storage temp	sample no.	Microcapsules conc.($\mu\text{g/ml}$)	Bisdesmethoxycurcumin			Desmethoxycurcumin		
			PA	Conc. ($\mu\text{g/ml}$)	% Content	PA	Conc. ($\mu\text{g/ml}$)	% Content
4°C	7.1	9.703	9174	0.159	1.63	41980	1.120	11.54
	7.2	9.703	7735	0.137	1.41	39596	1.057	10.90
	13.1	9.802	6963	0.125	1.28	32613	0.874	8.92
	13.2	9.802	6659	0.120	1.23	32386	0.868	8.86
	37.1	10.099	10379	0.177	1.75	47659	1.269	12.57
	37.2	9.901	9011	0.156	1.58	45534	1.213	12.25
	43.1	9.802	13241	0.220	2.25	61517	1.633	16.66
	43.2	10.099	12552	0.210	2.08	59964	1.592	15.76
	49.1	10.000	12140	0.204	2.04	51353	1.366	13.66
	49.2	10.099	12559	0.210	2.08	52385	1.393	13.79
RT	7.1	9.901	9120	0.129	1.30	39962	0.891	9.00
	7.2	10.000	8997	0.127	1.29	40001	0.891	9.00
	13.1	9.604	7484	0.133	1.38	34425	0.922	9.60
	13.2	9.604	5855	0.108	1.13	28152	0.757	7.88
	37.1	10.000	9632	0.136	1.36	43470	0.969	9.69
	37.2	9.802	6901	0.124	1.27	35339	0.946	9.65
	43.1	9.900	9223	0.159	1.62	48576	1.293	13.19
	43.2	9.703	8926	0.155	1.60	44872	1.196	12.32
	49.1	9.802	10864	0.154	1.57	47473	1.059	10.81
	49.2	10.099	10397	0.177	1.75	51277	1.364	13.51
40°C	7.1	9.802	9092	0.157	1.60	47473	1.264	12.90
	7.2	8.515	9019	0.156	1.83	38129	1.019	11.97
	13.1	9.604	8054	0.142	1.47	36615	0.979	10.19
	13.2	10.000	8611	0.150	1.50	36512	0.976	9.76
	37.1	9.703	9935	0.170	1.75	47952	1.277	13.16
	37.2	9.802	9804	0.168	1.71	43736	1.166	11.90
	43.1	9.802	11109	0.188	1.92	58071	1.542	15.73
	43.2	9.802	13030	0.217	2.21	59612	1.583	16.15
	49.1	10.099	9705	0.167	1.65	49619	1.320	13.08
	49.2	9.703	11124	0.188	1.94	49762	1.324	13.65
50°C	7.1	9.703	8836	0.153	1.58	44522	1.187	12.23
	7.2	9.208	9941	0.170	1.85	39867	1.064	11.56
	13.1	9.307	6887	0.124	1.33	33800	0.905	9.73
	13.2	8.614	5642	0.105	1.22	28424	0.764	8.87
	37.1	10.099	11447	0.193	1.91	49579	1.319	13.06
	37.2	9.802	8598	0.150	1.53	44711	1.192	12.16
	43.1	9.208	13184	0.219	2.38	58801	1.561	16.96
	43.2	9.703	13355	0.222	2.29	56893	1.511	15.58
	49.1	9.406	10941	0.185	1.97	48885	1.301	13.83
	49.2	9.604	10821	0.184	1.91	47870	1.275	13.27

Table 33. (Continued)

Storage temp	sample no.	Microcapsules conc.($\mu\text{g/ml}$)	Curcumin			Total curcuminoid	
			PA	Conc. ($\mu\text{g/ml}$)	% Content	Conc. ($\mu\text{g/ml}$)	% Content
4°C	7.1	9.703	150883	3.461	35.67	4.74	48.84
	7.2	9.703	141427	3.246	33.45	4.44	45.76
	13.1	9.802	119010	2.737	27.92	3.74	38.11
	13.2	9.802	115188	2.650	27.04	3.64	37.12
	37.1	10.099	170637	3.909	38.71	5.35	53.02
	37.2	9.901	164853	3.778	38.16	5.15	51.99
	43.1	9.802	220028	5.031	51.32	6.88	70.23
	43.2	10.099	214210	4.899	48.50	6.70	66.35
	49.1	10.000	185094	4.237	42.37	5.81	58.07
	49.2	10.099	189714	4.342	43.00	5.95	58.87
RT	7.1	0.000	142713	2.658	26.85	3.68	37.14
	7.2	10.000	150666	2.807	28.36	3.826	38.65
	13.1	9.604	120549	2.772	28.86	3.83	39.84
	13.2	9.604	103434	2.383	24.81	3.25	33.82
	37.1	0.000	158024	2.946	29.46	4.05	40.52
	37.2	9.802	127704	2.934	29.94	4.00	40.85
	43.1	9.900	163998	3.758	38.34	5.21	53.16
	43.2	9.703	173259	3.969	40.90	5.32	54.82
	49.1	0.000	220694	4.124	42.07	5.34	54.45
	49.2	10.099	186005	4.258	42.16	5.80	57.42
40°C	7.1	9.802	168613	3.863	39.41	5.28	53.91
	7.2	8.515	137812	3.164	37.16	4.34	50.96
	13.1	9.604	132448	3.042	31.67	4.16	43.34
	13.2	10.000	131766	3.027	30.27	4.15	41.53
	37.1	9.703	170835	3.914	40.33	5.36	55.24
	37.2	9.802	156689	3.592	36.65	4.93	50.26
	43.1	9.802	209334	4.788	48.85	6.52	66.50
	43.2	9.802	215440	4.926	50.26	6.73	68.62
	49.1	10.099	181205	4.149	41.08	5.64	55.81
	49.2	9.703	181688	4.160	42.87	5.67	58.46
50°C	7.1	9.703	159611	3.659	37.71	5.00	51.52
	7.2	9.208	144084	3.306	35.91	4.54	49.31
	13.1	9.307	119624	2.751	29.56	3.78	40.61
	13.2	8.614	101174	2.332	27.07	3.20	37.16
	37.1	10.099	178438	4.086	40.46	5.60	55.44
	37.2	9.802	158428	3.632	37.05	4.97	50.74
	43.1	9.208	207637	4.749	51.58	6.53	70.92
	43.2	9.703	204535	4.679	48.22	6.41	66.08
	49.1	9.406	181276	4.151	44.13	5.64	59.93
	49.2	9.604	175945	4.030	41.96	5.49	57.14

Determination of Curcuminoids Content in Microcapsules at Month 3

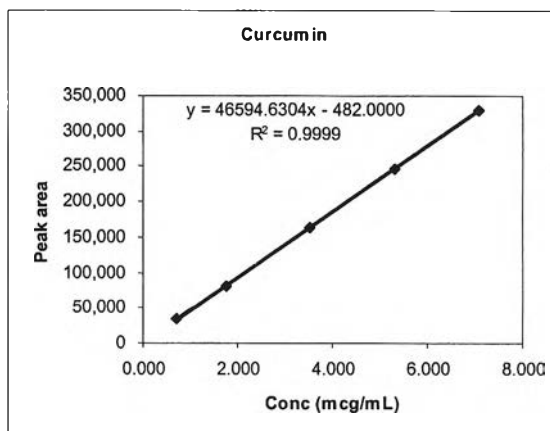


Figure 45. Standard curve of curcumin for month 3.

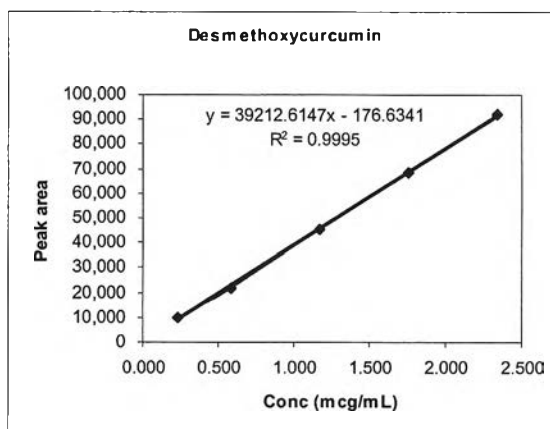


Figure 46. Standard curve of desmethoxycurcumin for month 3.

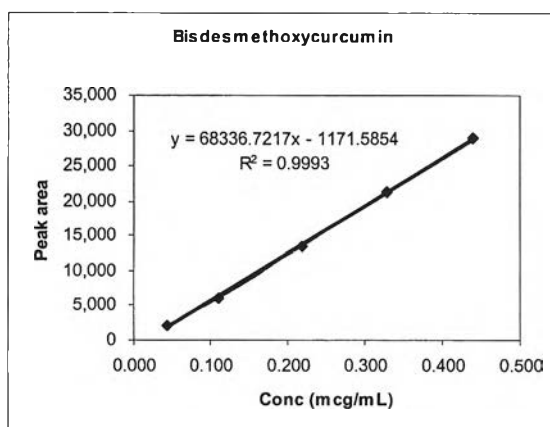


Figure 47. Standard curve of bisdesmethoxycurcumin for month 3.

Table 34. Peak area, curcuminoids concentration, and percent curcuminoids content of curcumin, desmethoxycurcumin, and bisdesmethoxycurcumin at month 3.

Storage temp	sample no.	Microcapsules conc.($\mu\text{g/ml}$)	Bisdesmethoxy curcumin			Desmethoxy curcumin		
			PA	Conc. ($\mu\text{g/ml}$)	% Content	PA	Conc. ($\mu\text{g/ml}$)	% Content
4C	7.1	9.802	6700	0.115	1.18	29634	0.760	7.76
	7.2	9.604	8210	0.137	1.43	35987	0.922	9.60
	13.1	9.703	5638	0.100	1.03	25547	0.656	6.76
	13.2	9.802	5369	0.096	0.98	25393	0.652	6.65
	37.1	10.000	9331	0.154	1.54	38490	0.986	9.86
	37.2	10.099	9640	0.158	1.57	41763	1.070	10.59
	43.1	9.901	11986	0.193	1.94	51483	1.317	13.31
	43.2	10.099	11879	0.191	1.89	52538	1.344	13.31
	49.1	9.802	9643	0.158	1.61	45147	1.156	11.79
	49.2	9.703	10000	0.163	1.68	43270	1.108	11.42
RT	7.1	9.802	7967	0.134	1.36	37152	0.952	9.71
	7.2	9.703	8611	0.143	1.48	36003	0.923	9.51
	13.1	10.000	7544	0.128	1.28	32682	0.838	8.38
	13.2	10.000	6926	0.118	1.18	29960	0.769	7.69
	37.1	9.802	8629	0.143	1.46	38431	0.985	10.04
	37.2	9.802	9001	0.149	1.52	38540	0.987	10.07
	43.1	9.901	12697	0.203	2.05	49773	1.274	12.87
	43.2	9.703	12555	0.201	2.07	50050	1.281	13.20
	49.1	9.901	9963	0.163	1.65	44491	1.139	11.50
	49.2	9.604	9508	0.156	1.63	43472	1.113	11.59
40C	7.1	9.802	7751	0.131	1.33	36571	0.937	9.56
	7.2	9.703	7899	0.133	1.37	34968	0.896	9.24
	13.1	9.505	5531	0.098	1.03	28161	0.723	7.60
	13.2	9.604	6378	0.110	1.15	27532	0.707	7.36
	37.1	9.901	7212	0.123	1.24	33646	0.863	8.71
	37.2	9.802	7801	0.131	1.34	38614	0.989	10.09
	43.1	10.198	11744	0.189	1.85	52174	1.335	13.09
	43.2	9.604	10829	0.176	1.83	47526	1.217	12.67
	49.1	9.901	9649	0.158	1.60	41708	1.068	10.79
	49.2	9.604	8427	0.140	1.46	36715	0.941	9.80
50C	7.1	10.297	8100	0.136	1.32	36720	0.941	9.14
	7.2	9.901	6858	0.118	1.19	32703	0.838	8.47
	13.1	10.693	6067	0.106	0.99	26637	0.684	6.39
	13.2	9.901	6043	0.106	1.07	27275	0.700	7.07
	37.1	10.198	8780	0.146	1.43	37725	0.967	9.48
	37.2	9.901	8975	0.148	1.50	43250	1.107	11.19
	43.1	10.000	11335	0.183	1.83	49460	1.266	12.66
	43.2	10.000	11039	0.179	1.79	50727	1.298	12.98
	49.1	10.297	8117	0.136	1.32	40153	1.028	9.99
	49.2	9.604	8488	0.141	1.47	40418	1.035	10.78

Table 34. (Continued)

Storage temp	sample no.	Microcapsules conc. ($\mu\text{g/ml}$)	Curcumin			Total curcuminoid	
			PA	Conc. ($\mu\text{g/ml}$)	% Content	Conc. ($\mu\text{g/ml}$)	% Content
4C	7.1	9.802	109284	2.356	24.03	3.23	32.96
	7.2	9.604	130251	2.806	29.21	3.87	40.25
	13.1	9.703	93575	2.019	20.80	2.77	28.59
	13.2	9.802	97073	2.094	21.36	2.84	28.99
	37.1	10.000	146170	3.147	31.47	4.29	42.87
	37.2	10.099	152158	3.276	32.44	4.50	44.59
	43.1	9.901	191072	4.111	41.52	5.62	56.77
	43.2	10.099	190383	4.096	40.56	5.63	55.76
	49.1	9.802	166002	3.573	36.45	4.89	49.86
	49.2	9.703	157339	3.387	34.91	4.66	48.01
RT	7.1	9.802	137289	2.957	30.17	4.04	41.24
	7.2	9.703	132197	2.847	29.35	3.91	40.33
	13.1	10.000	116834	2.518	25.18	3.48	34.83
	13.2	10.000	106413	2.294	22.94	3.18	31.81
	37.1	9.802	138634	2.986	30.46	4.11	41.97
	37.2	9.802	141461	3.046	31.08	4.18	42.67
	43.1	9.901	190819	4.106	41.47	5.58	56.38
	43.2	9.703	185948	4.001	41.24	5.48	56.51
	49.1	9.901	163611	3.522	35.57	4.82	48.72
	49.2	9.604	160202	3.449	35.91	4.72	49.12
40C	7.1	9.802	131402	2.830	28.88	3.90	39.77
	7.2	9.703	129933	2.799	28.85	3.83	39.45
	13.1	9.505	100075	2.158	22.71	2.98	31.34
	13.2	9.604	100392	2.165	22.54	2.98	31.05
	37.1	9.901	126119	2.717	27.44	3.70	37.39
	37.2	9.802	138925	2.992	30.52	4.11	41.95
	43.1	10.198	188990	4.066	39.87	5.59	54.82
	43.2	9.604	184996	3.981	41.45	5.37	55.94
	49.1	9.901	156730	3.374	34.08	4.60	46.46
	49.2	9.604	143611	3.092	32.20	4.17	43.46
50C	7.1	10.297	135260	2.913	28.29	3.99	38.75
	7.2	9.901	121165	2.611	26.37	3.57	36.02
	13.1	10.693	98581	2.126	19.88	2.92	27.27
	13.2	9.901	100989	2.178	22.00	2.98	30.13
	37.1	10.198	137890	2.970	29.12	4.08	40.03
	37.2	9.901	155757	3.353	33.87	4.61	46.55
	43.1	10.000	178882	3.849	38.49	5.30	52.98
	43.2	10.000	185137	3.984	39.84	5.46	54.60
	49.1	10.297	147817	3.183	30.91	4.35	42.22
	49.2	9.604	154226	3.320	34.57	4.50	46.82

Determination of Curcuminoids Content in Microcapsules-Containing Skin-Care Preparations

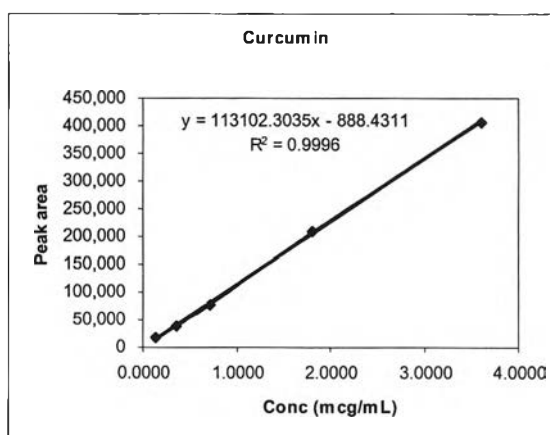


Figure 48. Standard curve of curcumin for determination of curcuminoids in skin-care preparations

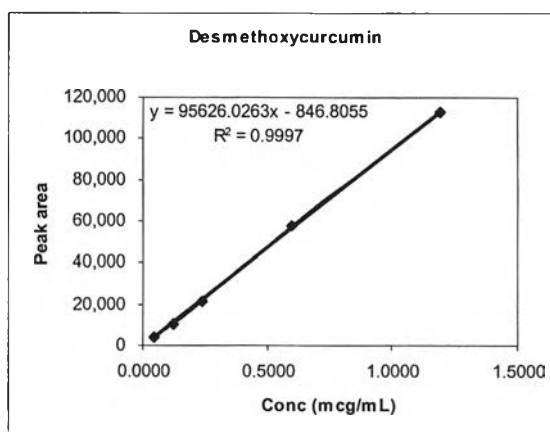


Figure 49. Standard curve of desmethoxycurcumin for determination of curcuminoids in skin-care preparations.

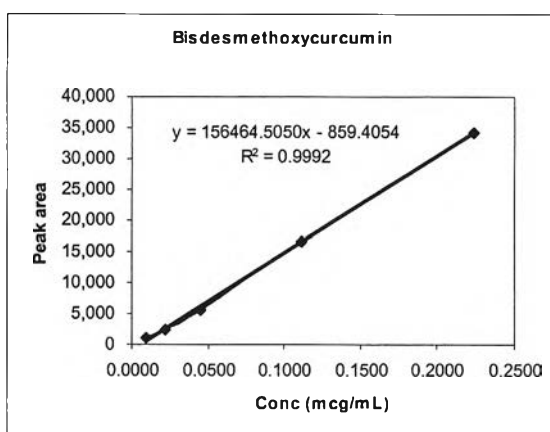


Figure 50. Standard curve of bisdesmethoxycurcumin for determination of curcuminoids in skin-care preparations.

Table 35. Peak area, curcuminoids concentration, and percent curcuminoids content of curcumin, desmethoxycurcumin, and bisdesmethoxycurcumin at week 0.

Preparations	no.	conc. of microcapsules ($\mu\text{g/ml}$)	Bisdesmethoxycurcumin			Desmethoxycurcumin		
			PA	Conc. ($\mu\text{g/ml}$)	% Content	PA	Conc. ($\mu\text{g/ml}$)	% Content
microcapsule in cleansing gel pH5	7.1	4.051	3059	0.026	0.65	14536	0.161	3.97
	7.2	4.069	3164	0.027	0.67	18385	0.201	4.94
	13.1	3.812	1928	0.019	0.51	12294	0.137	3.60
	13.2	3.920	2663	0.024	0.61	16212	0.178	4.55
	37.1	4.093	4689	0.037	0.90	20592	0.224	5.48
	37.2	4.064	3783	0.031	0.76	20694	0.225	5.54
	43.1	7.930	4252	0.034	0.43	22623	0.245	3.10
	43.2	3.990	6154	0.046	1.15	29730	0.320	8.01
	49.1	4.263	3767	0.031	0.72	20122	0.219	5.14
	49.2	4.240	4289	0.034	0.81	25122	0.272	6.40
microcapsule in cleansing gel pH7	7.1	4.095	3113	0.027	0.65	16380	0.180	4.40
	7.2	4.099	3918	0.032	0.78	20799	0.226	5.52
	13.1	3.851	2173	0.021	0.54	12050	0.135	3.50
	13.2	3.782	2570	0.023	0.62	13619	0.151	4.00
	37.1	4.438	4632	0.036	0.82	20899	0.227	5.12
	37.2	4.488	4889	0.038	0.85	23822	0.258	5.75
	43.1	4.629	5820	0.044	0.95	25034	0.271	5.85
	43.2	4.598	5895	0.044	0.96	28836	0.310	6.75
	49.1	4.338	4475	0.035	0.81	23365	0.253	5.84
	49.2	4.292	4791	0.037	0.87	26028	0.281	6.55
microcapsule in cleansing gel pH8	7.1	4.022	1795	0.018	0.46	7114	0.083	2.07
	7.2	4.073	1884	0.019	0.47	8842	0.101	2.49
	13.1	4.154	1703	0.018	0.43	5488	0.066	1.59
	13.2	4.173	1530	0.017	0.40	5287	0.064	1.54
	37.1	4.542	1315	0.015	0.34	8096	0.094	2.06
	37.2	4.582	1565	0.017	0.37	8729	0.100	2.19
	43.1	4.326	1517	0.017	0.39	9653	0.110	2.54
	43.2	4.296	2159	0.021	0.48	11356	0.128	2.97
	49.1	4.571	1590	0.017	0.37	9888	0.112	2.46
	microcapsules in cream	7.1	2.918	2177	0.021	0.71	15839	0.174
7.2		2.788	2506	0.023	0.82	9835	0.112	4.01
13.1		2.961	1046	0.014	0.46	9284	0.106	3.58
13.2		3.005	1148	0.014	0.48	7686	0.089	2.97
37.1		3.065	3100	0.027	0.87	16637	0.183	5.97
37.2		3.040	3364	0.028	0.93	13343	0.148	4.88
43.1		3.026	4459	0.035	1.17	22607	0.245	8.11
43.2		2.975	2079	0.020	0.68	21946	0.238	8.01
49.1		3.105	1924	0.019	0.62	11841	0.133	4.27
49.2		3.189	2238	0.021	0.67	7894	0.091	2.87
uncoated curcuminoids	ph5	0.982	1591	0.017	1.75	7322	0.085	8.70
	ph5	1.039	1919	0.019	1.85	5364	0.065	6.25
	ph7	1.049	1907	0.019	1.82	9836	0.112	10.65
	ph7	1.007	1866	0.019	1.87	11423	0.128	12.74
	ph8	0.998	1732	0.018	1.81	6769	0.080	7.98
	ph8	0.982	3088	0.027	2.71	10201	0.116	11.76
	cream	1.999	2250	0.021	1.07	12490	0.139	6.98
	cream	2.119	3146	0.027	1.27	12465	0.139	6.57

Table 35. (Continued)

Preparations	no.	conc. of microcapsules ($\mu\text{g/ml}$)	Curcumin			Total curcuminoids	
			PA	Conc. ($\mu\text{g/ml}$)	% Content	Conc. ($\mu\text{g/ml}$)	% Content
microcapsule in cleansing gel pH5	7.1	4.051	51940	0.467	11.53	0.65	16.15
	7.2	4.069	68598	0.614	15.10	0.84	20.71
	13.1	3.812	43142	0.389	10.21	0.55	14.32
	13.2	3.920	58424	0.524	13.38	0.73	18.54
	37.1	4.093	72848	0.652	15.93	0.91	22.30
	37.2	4.064	78400	0.701	17.25	0.96	23.55
	43.1	7.930	81030	0.724	9.13	1.00	12.66
	43.2	3.990	111412	0.993	24.89	1.36	34.05
	49.1	4.263	72336	0.647	15.19	0.90	21.06
	49.2	4.240	92631	0.827	19.50	1.13	26.71
microcapsule in cleansing gel pH7	7.1	4.095	60917	0.546	13.35	0.75	18.40
	7.2	4.099	77303	0.691	16.87	0.95	23.16
	13.1	3.851	43482	0.392	10.19	0.55	14.23
	13.2	3.782	51493	0.463	12.25	0.64	16.86
	37.1	4.438	75623	0.676	15.24	0.94	21.18
	37.2	4.488	89575	0.800	17.82	1.10	24.41
	43.1	4.629	91605	0.818	17.67	1.13	24.46
	43.2	4.598	106215	0.947	20.59	1.30	28.31
	49.1	4.338	86395	0.772	17.79	1.06	24.44
	49.2	4.292	99264	0.886	20.63	1.20	28.05
microcapsule in cleansing gel pH8	7.1	4.022	26592	0.243	6.04	0.34	8.57
	7.2	4.073	33426	0.303	7.45	0.42	10.40
	13.1	4.154	19923	0.184	4.43	0.27	6.45
	13.2	4.173	21319	0.196	4.71	0.28	6.64
	37.1	4.542	25041	0.229	5.05	0.34	7.45
	37.2	4.582	28528	0.260	5.68	0.38	8.23
	43.1	4.326	30920	0.281	6.50	0.41	9.42
	43.2	4.296	34189	0.310	7.22	0.46	10.67
	49.1	4.571	33064	0.300	6.57	0.43	9.40
	microcapsules in cream	7.1	2.918	56734	0.509	17.46	0.70
7.2		2.788	38154	0.345	12.38	0.48	17.21
13.1		2.961	34692	0.315	10.62	0.43	14.66
13.2		3.005	26046	0.238	7.92	0.34	11.37
37.1		3.065	62796	0.563	18.37	0.77	25.21
37.2		3.040	51831	0.466	15.33	0.64	21.15
43.1		3.026	87010	0.777	25.68	1.06	34.96
43.2		2.975	81809	0.731	24.58	0.99	33.27
49.1		3.105	42149	0.381	12.26	0.53	17.15
49.2		3.189	45703	0.412	12.92	0.52	16.45
uncoated curcuminoids	ph5	0.982	28377	0.259	26.34	0.36	36.79
	ph5	1.039	23912	0.219	21.11	0.30	29.21
	ph7	1.049	36518	0.331	31.52	0.46	43.99
	ph7	1.007	43309	0.391	38.81	0.54	53.42
	ph8	0.998	24180	0.222	22.20	0.32	31.98
	ph8	0.982	35757	0.324	32.99	0.47	47.47
	cream	1.999	46098	0.415	20.78	0.58	28.82
	cream	2.119	45603	0.411	19.40	0.58	27.24

Table 36. Peak area, curcuminoids concentration, and percent curcuminoids content of curcumin, desmethoxycurcumin, and bisdesmethoxycurcumin at week 2.

Preparations	no.	conc. of microcapsules ($\mu\text{g/ml}$)	Bisdesmethoxycurcumin			Desmethoxycurcumin		
			PA	Conc.	%	PA	Conc.	%
microcapsule in cleansing gel pH5	7.1	6.086	2606	0.024	0.39	14299	0.158	2.60
	7.2	6.445	3921	0.032	0.49	19329	0.211	3.27
	13.1	6.116	1852	0.019	0.31	9912	0.113	1.84
	13.2	5.832	2451	0.023	0.39	13524	0.150	2.58
	37.1	6.169	3877	0.032	0.51	17479	0.192	3.11
	37.2	6.080	4256	0.034	0.56	19013	0.208	3.42
	43.1	6.104	4977	0.039	0.63	24050	0.260	4.27
	43.2	6.105	5407	0.041	0.68	27041	0.292	4.78
	49.1	6.398	2187	0.021	0.33	11821	0.132	2.07
	49.2	6.330	2411	0.022	0.35	12467	0.139	2.20
microcapsule in cleansing gel pH7	7.1	6.160	2452	0.023	0.37	15298	0.169	2.74
	7.2	6.313	3324	0.028	0.44	17696	0.194	3.07
	13.1	5.727	2097	0.020	0.36	10932	0.123	2.15
	13.2	5.726	1436	0.016	0.28	11710	0.131	2.29
	37.1	6.757	3901	0.032	0.47	19316	0.211	3.12
	37.2	6.733	4017	0.032	0.48	19773	0.216	3.20
	43.1	6.955	4622	0.036	0.52	21968	0.239	3.43
	43.2	7.364	4997	0.039	0.52	23366	0.253	3.44
	49.1	6.623	3231	0.028	0.42	16590	0.182	2.75
	49.2	6.481	2667	0.024	0.37	16150	0.178	2.74
microcapsule in cleansing gel pH8	7.1	5.919	UD	UD	UD	953	0.019	0.32
	7.2	6.074	693	0.011	0.19	2153	0.031	0.52
	13.1	6.361	UD	UD	UD	1507	0.025	0.39
	13.2	6.198	UD	UD	UD	1298	0.022	0.36
	37.1	6.727	UD	UD	UD	1705	0.027	0.40
	37.2	6.937	UD	UD	UD	1788	0.028	0.40
	43.1	6.762	UD	UD	UD	1353	0.023	0.34
	43.2	6.517	682	0.011	0.17	1554	0.025	0.39
	49.1	6.593	626	0.011	0.17	1489	0.024	0.37
	49.2	6.621	751	0.012	0.18	1807	0.028	0.42
microcapsules in cream	7.1	4.978	916	0.013	0.26	8668	0.100	2.00
	7.2	4.919	2203	0.021	0.43	11087	0.125	2.54
	13.1	5.000	698	0.012	0.23	1668	0.026	0.53
	13.2	4.949	1031	0.014	0.27	2012	0.030	0.60
	37.1	5.056	987	0.013	0.26	5505	0.066	1.31
	37.2	5.158	1443	0.016	0.31	6942	0.081	1.58
	43.1	5.078	1398	0.016	0.31	6628	0.078	1.54
	43.2	4.962	1683	0.018	0.36	7877	0.091	1.84
	49.1	5.119	1673	0.018	0.34	6941	0.081	1.59
	49.2	5.198	2109	0.020	0.39	9972	0.113	2.18
uncoated curcuminoids	ph5	2.152	3056	0.026	1.23	11436	0.128	5.97
	ph5	1.988	3083	0.027	1.34	11133	0.125	6.30
	ph7	2.010	3184	0.027	1.35	10820	0.122	6.07
	ph7	2.013	5259	0.040	2.00	16216	0.178	8.86
	ph8	2.069	UD	UD	UD	1118	0.021	0.99
	ph8	1.946	870	0.013	0.65	2560	0.036	1.83
	cream	4.055	1800	0.018	0.46	8004	0.093	2.28
	cream	4.146	3761	0.031	0.74	13883	0.154	3.71

Table 36. (Continued)

Preparations	no.	conc. of microcapsules ($\mu\text{g/ml}$)	Curcumin			Total curcuminoids	
			PA	Conc.	%	Conc.	%
microcapsule in cleansing gel pH5	7.1	6.086	53781	0.483	7.94	0.67	10.93
	7.2	6.445	72161	0.646	10.02	0.89	13.79
	13.1	6.116	37797	0.342	5.59	0.47	7.74
	13.2	5.832	51237	0.461	7.90	0.63	10.87
	37.1	6.169	65788	0.590	9.56	0.81	13.17
	37.2	6.080	72376	0.648	10.65	0.89	14.63
	43.1	6.104	88691	0.792	12.98	1.09	17.87
	43.2	6.105	96177	0.858	14.06	1.19	19.51
	49.1	6.398	45299	0.408	6.38	0.56	8.78
	49.2	6.330	49515	0.446	7.04	0.61	9.59
microcapsule in cleansing gel pH7	7.1	6.160	59288	0.532	8.64	0.72	11.74
	7.2	6.313	67192	0.602	9.53	0.82	13.05
	13.1	5.727	40768	0.368	6.43	0.51	8.94
	13.2	5.726	40266	0.364	6.35	0.51	8.93
	37.1	6.757	72732	0.651	9.63	0.89	13.22
	37.2	6.733	75124	0.672	9.98	0.92	13.67
	43.1	6.955	81927	0.732	10.53	1.01	14.48
	43.2	7.364	87794	0.784	10.65	1.08	14.61
	49.1	6.623	62609	0.561	8.48	0.77	11.64
49.2	6.481	60202	0.540	8.33	0.74	11.45	
microcapsule in cleansing gel pH8	7.1	5.919	6750	0.068	1.14	0.09	1.46
	7.2	6.074	10642	0.102	1.68	0.14	2.38
	13.1	6.361	4429	0.047	0.74	0.07	1.13
	13.2	6.198	4974	0.052	0.84	0.07	1.20
	37.1	6.727	1984	0.025	0.38	0.05	0.77
	37.2	6.937	3487	0.039	0.56	0.07	0.95
	43.1	6.762	2106	0.026	0.39	0.05	0.73
	43.2	6.517	1246	0.019	0.29	0.06	0.85
	49.1	6.593	2667	0.031	0.48	0.07	1.01
	49.2	6.621	2873	0.033	0.50	0.07	1.10
microcapsules in cream	7.1	4.978	31831	0.289	5.81	0.40	8.07
	7.2	4.919	41092	0.371	7.55	0.52	10.51
	13.1	5.000	9074	0.088	1.76	0.13	2.52
	13.2	4.949	11314	0.108	2.18	0.15	3.06
	37.1	5.056	19933	0.184	3.64	0.26	5.22
	37.2	5.158	26070	0.238	4.62	0.34	6.51
	43.1	5.078	24764	0.227	4.47	0.32	6.32
	43.2	4.962	30418	0.277	5.58	0.39	7.77
	49.1	5.119	24490	0.224	4.38	0.32	6.32
	49.2	5.198	34203	0.310	5.97	0.44	8.54
uncoated curcuminoids	ph5	2.152	41345	0.373	17.35	0.53	24.54
	ph5	1.988	41336	0.373	18.78	0.53	26.41
	ph7	2.010	34652	0.314	15.63	0.46	23.06
	ph7	2.013	54673	0.491	24.41	0.71	35.27
	ph8	2.069	4864	0.051	2.46	0.07	3.45
	ph8	1.946	9404	0.091	4.68	0.14	7.16
	cream	4.055	28761	0.262	6.46	0.37	9.20
	cream	4.146	49136	0.442	10.67	0.63	15.13

Table 37. Peak area, curcuminoids concentration, and percent curcuminoids content of curcumin, desmethoxycurcumin, and bisdesmethoxycurcumin at week 4.

Preparations	no.	conc. of microcapsules ($\mu\text{g/ml}$)	Bisdesmethoxycurcumin			Desmethoxycurcumin		
			PA	Conc.	%	PA	Conc.	%
microcapsule in cleansing gel pH5	7.1	5.898	2586	0.023	0.40	17228	0.189	3.20
	7.2	6.060	1507	0.017	0.27	17052	0.187	3.09
	13.1	5.861	699	0.012	0.20	7373	0.086	1.47
	13.2	5.871	1885	0.019	0.32	10889	0.123	2.09
	37.1	6.144	3048	0.026	0.43	16468	0.181	2.95
	37.2	6.294	3134	0.027	0.43	17730	0.194	3.09
	43.1	6.355	5080	0.039	0.62	24328	0.263	4.14
	43.2	5.958	4083	0.033	0.55	21663	0.235	3.95
	49.1	6.312	3198	0.027	0.43	14803	0.164	2.59
	49.2	6.434	2352	0.022	0.34	13381	0.149	2.31
microcapsule in cleansing gel pH7	7.1	6.256	1593	0.017	0.27	7229	0.084	1.35
	7.2	5.992	1680	0.018	0.30	6244	0.074	1.24
	13.1	6.133	1782	0.018	0.30	6190	0.074	1.20
	13.2	5.883	895	0.013	0.22	1965	0.029	0.50
	37.1	6.710	3279	0.028	0.41	16003	0.176	2.63
	37.2	6.603	3267	0.028	0.42	14138	0.157	2.37
	43.1	6.928	4683	0.037	0.53	16967	0.186	2.69
	43.2	7.026	2362	0.022	0.31	8278	0.095	1.36
	49.1	6.513	1653	0.018	0.27	5125	0.062	0.96
	49.2	6.557	1278	0.015	0.23	5157	0.063	0.96
microcapsule in cleansing gel pH8	7.1	5.816	UD	UD	UD	702	0.016	0.28
	7.2	6.126	UD	UD	UD	695	0.016	0.26
	13.1	6.257	UD	UD	UD	UD	UD	UD
	13.2	6.244	UD	UD	UD	UD	UD	UD
	37.1	6.885	UD	UD	UD	UD	UD	UD
	37.2	6.698	UD	UD	UD	UD	UD	UD
	43.1	6.361	UD	UD	UD	UD	UD	UD
	43.2	6.530	UD	UD	UD	UD	UD	UD
	49.1	6.577	UD	UD	UD	UD	UD	UD
	49.2	6.722	UD	UD	UD	UD	UD	UD
microcapsules in cream	7.1	2.928	1579	0.017	0.58	4763	0.059	2.00
	7.2	2.844	1748	0.018	0.64	8422	0.097	3.41
	13.1	3.071	1417	0.016	0.52	5623	0.068	2.20
	13.2	2.941	1502	0.017	0.56	5288	0.064	2.18
	37.1	3.039	2099	0.020	0.67	9696	0.110	3.63
	37.2	3.021	1509	0.017	0.55	9648	0.110	3.63
	43.1	3.032	2738	0.024	0.80	11154	0.125	4.14
	43.2	3.051	2731	0.024	0.80	9946	0.113	3.70
	49.1	3.174	1973	0.020	0.62	7779	0.090	2.84
	49.2	3.068	1428	0.016	0.53	5691	0.068	2.23
uncoated curcuminoids	ph5	10.062	12741	0.077	0.77	44701	0.441	4.38
	ph5	10.242	12673	0.077	0.75	43756	0.432	4.22
	ph7	9.818	11785	0.072	0.73	39254	0.390	3.97
	ph7	10.010	11342	0.069	0.69	39068	0.388	3.88
	ph8	10.120	3604	0.025	0.25	13236	0.146	1.44
	ph8	9.884	3611	0.025	0.26	13063	0.144	1.46
	cream	10.054	8673	0.054	0.54	33864	0.339	3.37
	cream	10.132	8590	0.054	0.53	34338	0.344	3.39

Table 37. (Continued)

Preparations	no.	conc. of microcapsules ($\mu\text{g/ml}$)	Curcumin			Total curcuminoids	
			PA	Conc.	%	Conc.	%
microcapsule in cleansing gel pH5	7.1	5.898	63625	0.570	9.67	0.78	13.27
	7.2	6.060	64566	0.579	9.55	0.78	12.91
	13.1	5.861	31261	0.284	4.85	0.38	6.51
	13.2	5.871	39975	0.361	6.15	0.50	8.57
	37.1	6.144	66022	0.592	9.63	0.80	13.00
	37.2	6.294	65711	0.589	9.36	0.81	12.87
	43.1	6.355	93012	0.830	13.06	1.13	17.82
	43.2	5.958	80311	0.718	12.05	0.99	16.55
	49.1	6.312	57661	0.518	8.20	0.71	11.23
	49.2	6.434	52737	0.474	7.37	0.64	10.02
microcapsule in cleansing gel pH7	7.1	6.256	24702	0.226	3.62	0.33	5.24
	7.2	5.992	24943	0.228	3.81	0.32	5.34
	13.1	6.133	24734	0.227	3.69	0.32	5.19
	13.2	5.883	8439	0.082	1.40	0.12	2.12
	37.1	6.710	62444	0.560	8.35	0.76	11.39
	37.2	6.603	52840	0.475	7.19	0.66	9.99
	43.1	6.928	65099	0.583	8.42	0.81	11.64
	43.2	7.026	31877	0.290	4.12	0.41	5.80
	49.1	6.513	22357	0.206	3.16	0.29	4.38
	49.2	6.557	20408	0.188	2.87	0.27	4.06
microcapsule in cleansing gel pH8	7.1	5.816	1420	0.020	0.35	0.04	0.63
	7.2	6.126	1353	0.020	0.32	0.04	0.59
	13.1	6.257	UD	UD	UD	UD	UD
	13.2	6.244	UD	UD	UD	UD	UD
	37.1	6.885	UD	UD	UD	UD	UD
	37.2	6.698	UD	UD	UD	UD	UD
	43.1	6.361	UD	UD	UD	UD	UD
	43.2	6.530	UD	UD	UD	UD	UD
	49.1	6.577	UD	UD	UD	UD	UD
	49.2	6.722	UD	UD	UD	UD	UD
microcapsules in cream	7.1	2.928	20058	0.185	6.32	0.26	8.91
	7.2	2.844	31363	0.285	10.03	0.40	14.07
	13.1	3.071	19584	0.181	5.89	0.26	8.62
	13.2	2.941	21629	0.199	6.77	0.28	9.51
	37.1	3.039	32699	0.297	9.77	0.43	14.07
	37.2	3.021	34261	0.311	10.29	0.44	14.47
	43.1	3.032	37965	0.344	11.33	0.49	16.27
	43.2	3.051	36235	0.328	10.76	0.47	15.26
	49.1	3.174	28361	0.259	8.15	0.37	11.61
	49.2	3.068	20549	0.190	6.18	0.27	8.93
uncoated curcuminoids	ph5	10.062	161315	1.333	13.24	1.85	18.39
	ph5	10.242	162697	1.344	13.12	1.85	18.09
	ph7	9.818	142011	1.178	12.00	1.64	16.70
	ph7	10.010	142677	1.183	11.82	1.64	16.39
	ph8	10.120	48952	0.431	4.26	0.60	5.95
	ph8	9.884	49553	0.436	4.41	0.61	6.13
	cream	10.054	116458	0.973	9.68	1.37	13.59
	cream	10.132	115994	0.969	9.57	1.37	13.49



VITA

Miss Umasom Onsrithong was born on 8th June 1978, in Bangkok, Thailand. She graduated the Bachelor of Science in Biotechnology in the major of Agro-industry, Assumption University, Bangkok, Thailand. She had been worked in Picaso Naturals Laboratory Co., Ltd., the Japanese company manufacturing cosmetics and personal care products for a year before enrolling the Master's Degree of International Pharmaceutical Technology at Chulalongkorn University. She is now working for Baibua Co., Ltd. in the department of product development.