CHAPTER III

RESULTS

3.1 Properties of the Yeast Extract Powder

3.1.1 Morphology

The photomicrograph of the yeast extract powder is illustrated in Figure 3-1.

3.1.2 Particle Size Distibution and Specific Surface Area

The histogram for the particle size distribution and its cumulative percent under size is shown in Figure 3-2. The average particle size is 10.92 μm. (volume surface mean diameter), 28.95 μm. (weight moment mean diameter) and its specific surface area is 0.5494 m^2./ml.. The data table also indicates that the numerical median diameter is 14.45 μm..

3.1.3 Thermal Characteristics

A 5.7 milligrams of the yeast extract powder was determined at atmosphere of nitrogen gas 30 ml./min., with a heating rate of 10 $^{\circ}$C/min., sensitivity of $\pm$ 50 μV., and 5 mm./min. chart speed. DTA thermogram of the yeast extract powder heated from room temperature to 300 $^{\circ}$C is shown in Figure 3-3.

3.1.4 Moisture Adsorption Isotherm

The moisture adsorption isotherm of the yeast extract powder is shown in Figure 3-4.

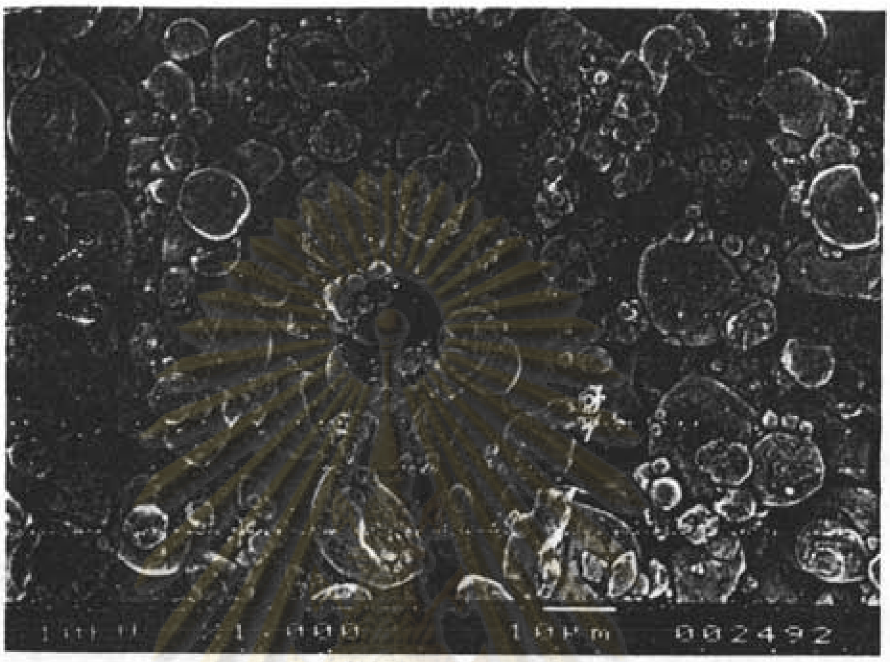

Figure 3-1 Photomicrograph of Yeast Extract Powder

Size microns	% under	% in band	Size microns	% under	% in band
188	100	2.06	17.7	59.4	6.76
162	97.9	1.92	15.3	52.6	6.71
140	96.0	1.97	13.2	45.9	6.33
121	94.0	2.04	11.4	39.6	6.08
104	92.0	1.88	9.81	33.5	5.47
89.9	90.1	1.69	8.46	28.0	4.68
77.5	88.4	1.52	7.30	23.4	4.05
66.9	86.9	1.48	6.30	19.3	4.07
57.7	85.4	1.37	5.43	15.2	4.82
49.8	84.1	1.33	4.59	10.4	5.34
42.9	82.7	1.58	4.05	5.08	3.57
37.1	81.1	2.21	3.49	1.51	1.22
32.0	78.9	3.11	3.01	0.29	0.27
27.6	75.8	4.32	2.60	0.03	0.03
23.9	71.5	5.61	2.24	0.00	0.00
20.5	65.9	5.51	1.93	0.00	

Result source=Sample
Record No. = 0
Focal length = 100 mm.
Presentation =pia
Volume distribution
Beam length = 20.0 mm.
Obscuration =0.0054
Volume Conc. = 0.0001 %
Log. Diff. = 6.079
Model indp

D(v,0.5) = 14.45 µm
D(v,0.9) = 89.00 µm
D(v,0.1) = 4.64 µm
D(4,3) = 28.95 µm
D(3,2) = 10.92 µm
Span = 5.84
Spec. surf. area
0.5494 sq.m./cc.

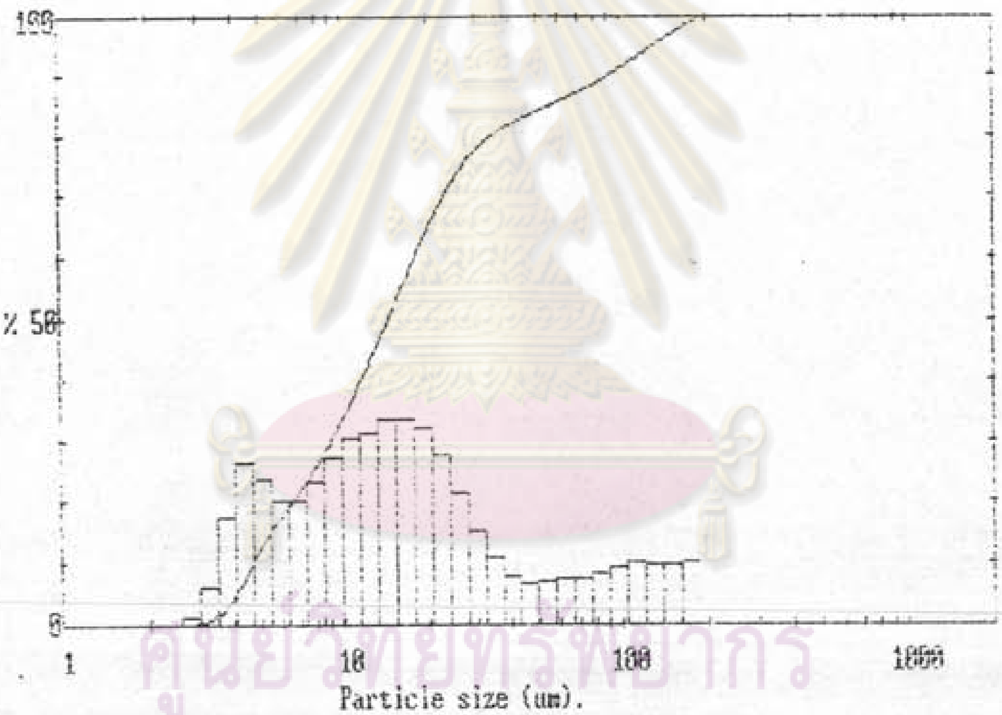

Figure 3-2 Histogram for the Particle Size Distribution and Cumulative Percent Undersize of Yeast Extract Powder

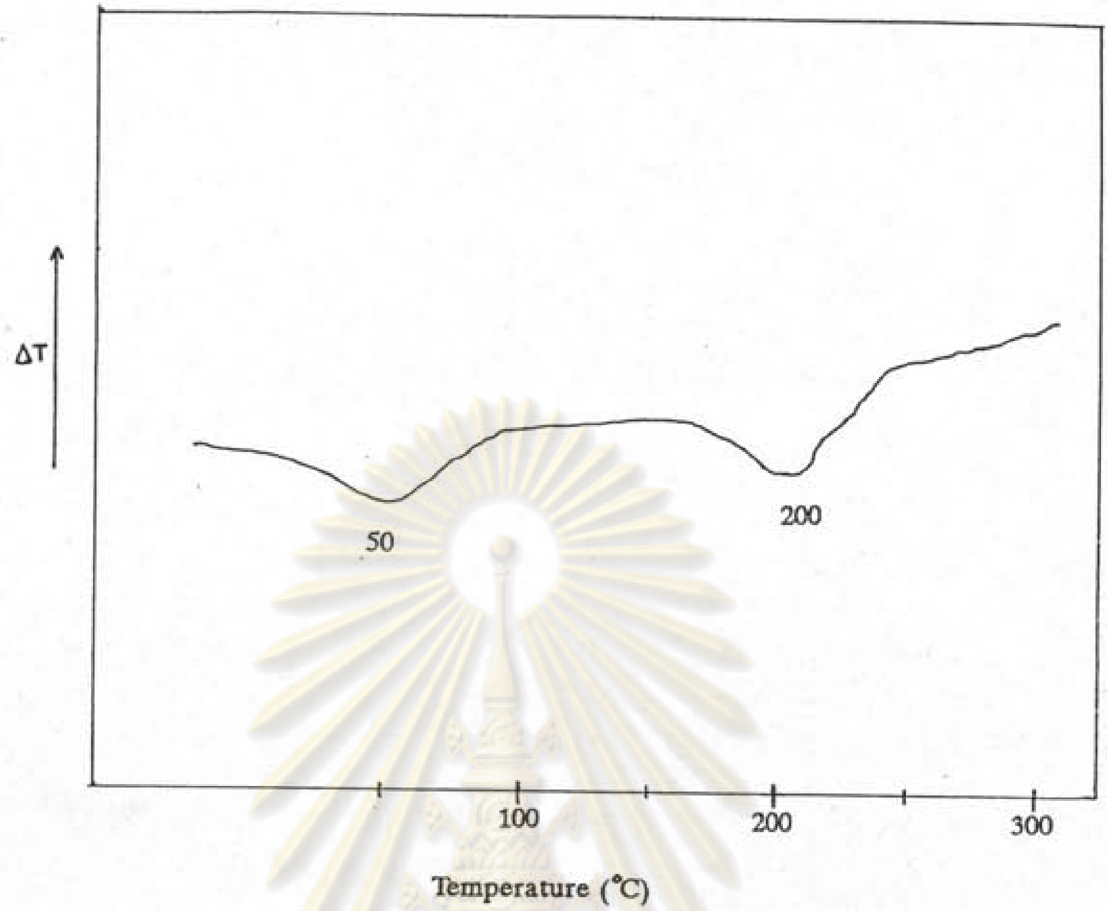

Figure 3-3 DTA Thermogram of Yeast Extract Powder

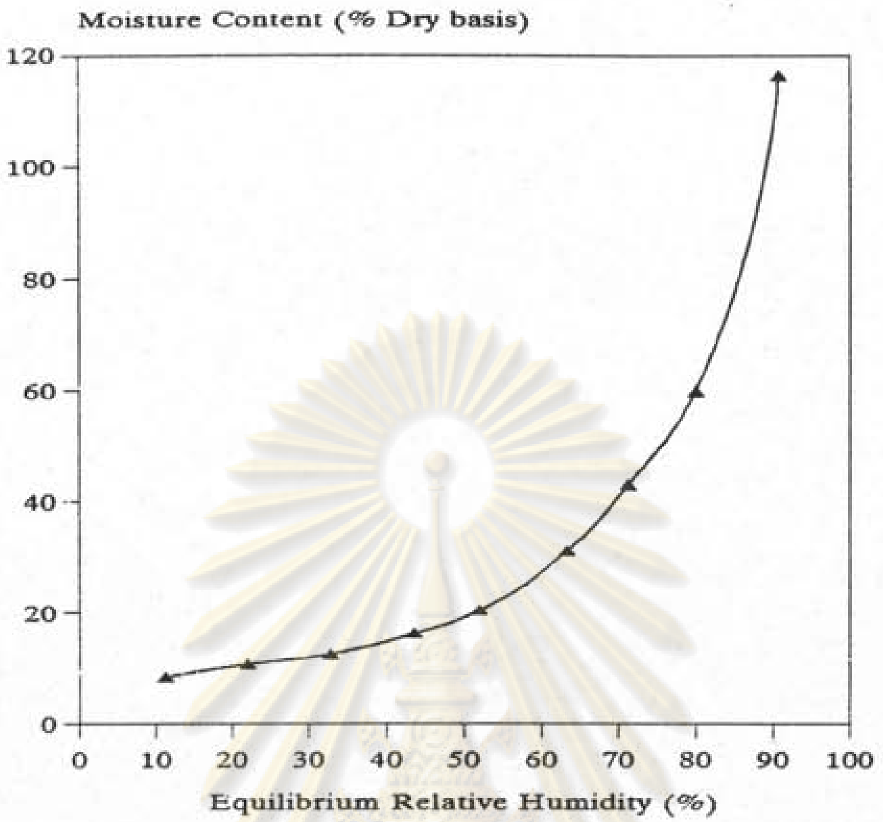

Figure 3-4 Moisture Adsorption Isotherm of Yeast Extract Powder

3.1.5 Moisture Content, Flowability, Solubility, Bulk Density, Tapped Density, Percent Compressibility, and True Density

The results of moisture content, flowability, solubility, bulk density, tapped density, percent compressibility, and true density of the yeast extract powder are presented in Table 3-1.

3.2 Preliminary Studies

Before proceeding with the tablet making process, preliminary investigation of suitable method and ingredients was carried out by the trial and error method. During the trial, the proper granulation process, the general and cheaper ingredients, and the acceptable appearance of tablet were chosen to be the basis for further decision making. The results of the preliminary investigation is shown in Table 3-2 and Figure 3-5.

The formulation for further studies of factorial experiment was concluded to consist of ingredients as follow :

adsorbent (factor A) - magnesium carbonate light at level of 22.0 and 16.0 mg.

diluents - corn starch : dibasic calcium phosphate = 1 : 1

binder (factor B) - corn starch paste at level of 6.8 and 3.4 mg.

disintegrant (factor C) - dried corn starch at level of 24 and 14.5 mg.

glidant - Cab-O-Sil®

lubricant (factor D) - magnesium stearate at level of 3.0 and 1.6 mg.

Table 3-1 Physical Properties of Yeast Extract Powder

Parameter	Value
Moisture content	7.59 ± 0.23 % (Dry basis)
Flow rate	0 g./ sec.
Bulk density	0.52 ± 0.02 g./ml.
Tapped density	0.67 ± 0.02 g./ml.
True density	1.201 ± 0.028 g./ml.
Compressibility	22.00 ± 1.47 %
Solubility	0.4277 ± 0.0048 g./5ml. of filtrate

Table 3-2 Preliminary Investigation Results

Method	Excipient	Result
Direct compression	Cab-O-Sil® 1 % Emcompress® or Avicel PH101® < 60 %	flow problem, quickly absorb moisture, stick on upper punch
Wet massing	A. lactose 25 % corn starch 25 % corn starch paste 10% (concentration) dried corn starch 5% talcum 3 % magnesium stearate 1%	sticky wet mass, drying time > 10 hr., mottling on tablet surface
	B. calcium hydrogen phosphate 50% corn starch paste 10% dried corn starch 5% talcum 3 % magnesium stearate 1%	sticky wet mass, drying time > 10 hr., hardness > 10 kg.

Table 3-2 (cont.)

Method	Excipient	Result
	C. calcium hydrogen phosphate 25% corn starch 25% corn starch paste 10% dried corn starch 5% talcum 3% magnesium stearate 1%	less sticky wet mass, drying time approximately 10 hr., unacceptable appearance
	D. magnesium carbonate 50% corn starch paste 10% dried corn starch 5% talcum 3 % magnesium stearate 1 %	wet mass was screened easily, drying time approximately 3 hr., unacceptable appearance
	E. magnesium carbonate 25% corn starch 25% corn starch paste 5% dried corn starch 5% talcum 3 % magnesium stearate 1 %	unacceptable appearance unacceptable weight variation

Table 3-2 (cont.)

Method	Excipient	Result
	F. magnesium carbonate 10% corn starch 40% corn starch paste 5% dried corn starch 5% talcum 3 % magnesium stearate 1 %	tablet quickly absorb moisture
	G. magnesium carbonate 10% calcium hydrogen phosphate 10% corn starch paste 5% dried corn starch 5% talcum 3 % magnesium stearate 1 %	wet mass was stickier than F
	H. magnesium carbonate 10% corn starch 20% calcium hydrogen phosphate 20% corn starch paste 5% dried corn starch 5% talcum 3 % magnesium stearate 1 %	unacceptable weight variation, white spots on tablet surface

Table 3-2 (cont.)

Method	Excipient	Result
	I. magnesium carbonate 10% corn starch 20% calcium hydrogen phosphate 20% corn starch paste 5% dried corn starch 5% Cab-O-Sil® 0.5% magnesium stearate 0.5%	acceptable appearance
	J. magnesium carbonate 10% corn starch 20% calcium hydrogen phosphate 20% corn starch paste 5% Explotab® 5% Cab-O-Sil® 0.5% magnesium stearate 0.5%	disintegration time was not different from formula I

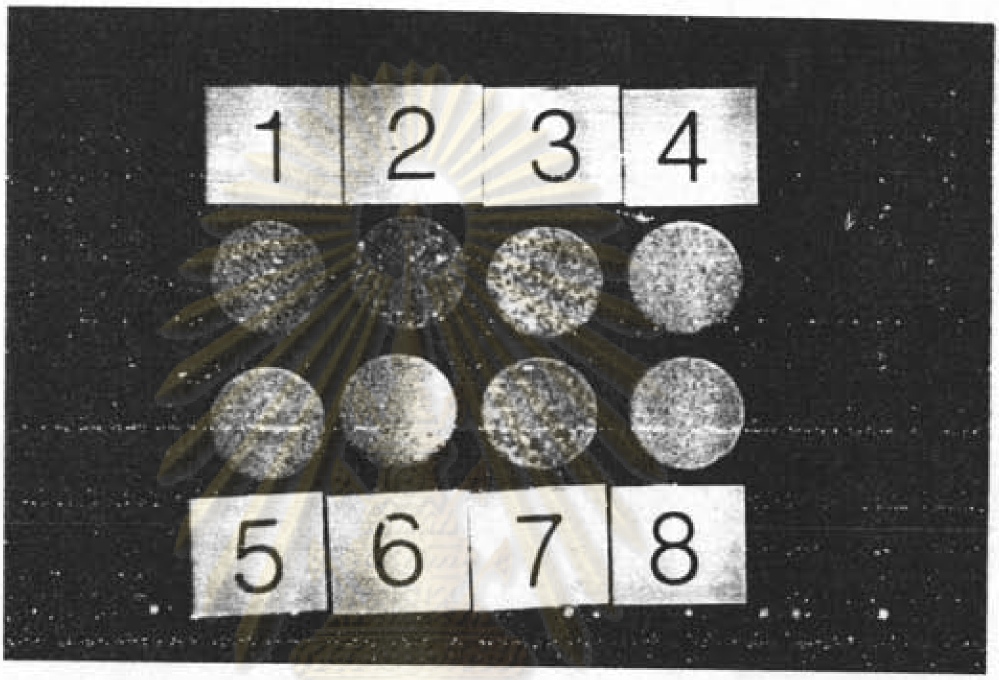

Figure 3-5 Yeast Extract Tablets from Preliminary Studies

(1) formula A
(2) formula B
(3) formula C
(4) formula D
(5) formula E
(6) formula F
(7) formula G
(8) formula H

3.3 Physical Properties of Yeast Extract Granules

3.3.1 Morphology

The photomicrograph of selected yeast extract granule (formula No. 5) is illustrated in Figure 3-6.

3.3.2 Particle Size Distribution

Histograms of the particle size distribution of various formulation are shown in Figure 3-7. Median diameter by weight of every formulations are in the range of 485 - 600 μm. (Table 3-3).

3.3.3 Moisture Content, Flow Rate, Bulk Density, Tapped Density, Percent Compressibility, and True Density

The results of moisture content, flow rate, bulk density, tapped density, percent compressibility, and true density of yeast extract granule are shown in Table 3-3 and Figure 3-8 to 3-12. According to 2^2 factorial design, the effects of magnesium carbonate light and corn starch paste on these parameters of the 16 granule formulations are not significant at 95 percent confidential level (Appendix B).

3.4 Physical Properties of Tablets

3.4.1 Weight Variation

The average weight, standard deviation, and percent of coefficient of variation of yeast extract tablets are listed in Table 3-4. Each formulation of yeast extract tablet possessed the weight variation within the requirement of the USP XXII standard except for formula No.1.

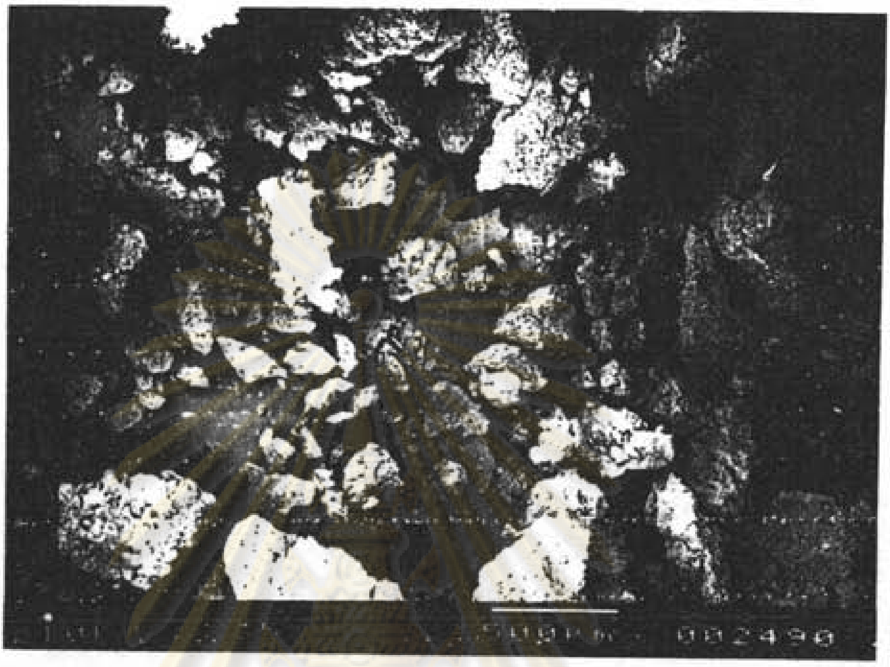

Figure 3-6 Photomicrograph of Selected Yeast Extract Granule

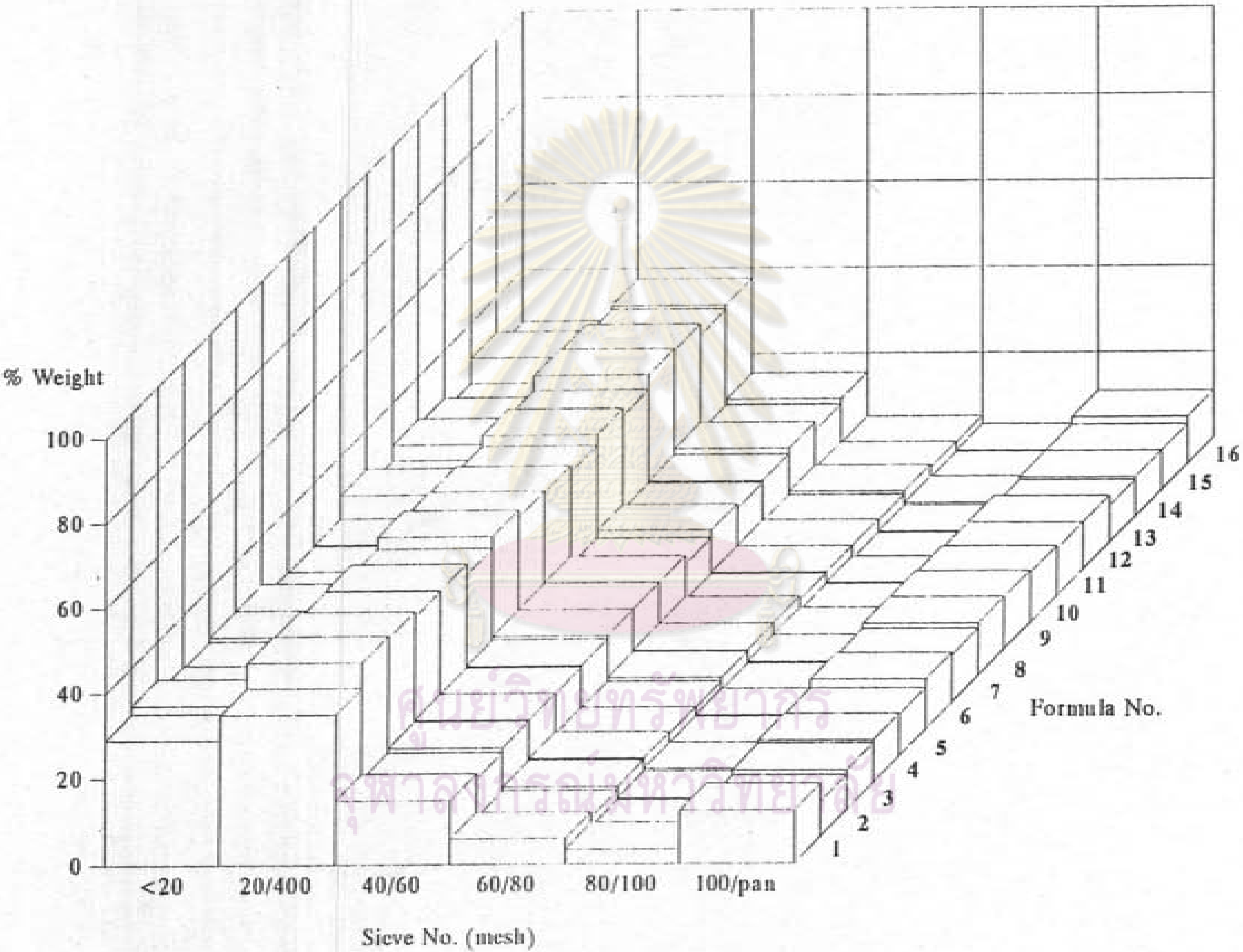

Figure 3-7 Histogram for Particle Size Distribution of 16 Granule Formulations

Table 3-3 Physical Properties of Yeast Extract Granules

Formula No.	Moisture Content ±S.D.(%)	Bulk Density ±S.D.(g./ml.)	Tapped Density ±S.D.(g./ml.)	True Density ±S.D.(g./ml.)	Compressibility ±S.D.(%)	Flow Rate ±S.D.(g./sec.)	Median Diameter (μm.)
1 (abcd)	4.26 ± 0.32	0.54 ± 0.02	0.66 ± 0.03	1.384 ± 0.072	17.22 ± 1.61	40.11 ± 2.63	520
2 (bcd)	3.33 ± 0.10	0.58 ± 0.02	0.69 ± 0.00	1.458 ± 0.002	15.46 ± 2.22	42.15 ± 1.08	600
3 (acd)	3.30 ± 0.29	0.58 ± 0.02	0.70 ± 0.04	1.420 ± 0.070	16.22 ± 1.23	38.33 ± 3.77	550
4 (cd)	3.23 ± 0.09	0.59 ± 0.02	0.68 ± 0.02	1.375 ± 0.043	13.16 ± 1.23	39.83 ± 5.40	530
5 (abd)	4.73 ± 0.53	0.60 ± 0.02	0.71 ± 0.02	1.359 ± 0.096	16.33 ± 1.09	39.43 ± 1.90	540
6 (bd)	3.98 ± 0.48	0.59 ± 0.02	0.72 ± 0.02	1.418 ± 0.081	18.06 ± 0.43	41.12 ± 1.19	530
7 (ad)	4.54 ± 0.33	0.56 ± 0.01	0.69 ± 0.02	1.363 ± 0.007	18.72 ± 2.48	41.33 ± 3.93	500
8 (d)	4.17 ± 0.31	0.57 ± 0.03	0.67 ± 0.03	1.411 ± 0.034	15.44 ± 2.31	43.45 ± 7.22	490
9 (abc)	3.73 ± 0.16	0.56 ± 0.02	0.69 ± 0.02	1.390 ± 0.051	18.83 ± 2.34	44.65 ± 0.70	485
10 (bc)	3.47 ± 0.07	0.57 ± 0.01	0.69 ± 0.02	1.409 ± 0.024	17.85 ± 1.78	41.42 ± 2.45	550
11 (ac)	3.58 ± 0.03	0.56 ± 0.00	0.67 ± 0.02	1.399 ± 0.068	15.93 ± 2.97	42.74 ± 0.62	510
12 (c)	3.70 ± 0.07	0.55 ± 0.02	0.68 ± 0.01	1.315 ± 0.107	18.20 ± 2.42	42.55 ± 1.89	550
13 (ab)	3.50 ± 0.06	0.56 ± 0.01	0.67 ± 0.02	1.327 ± 0.111	15.90 ± 1.29	43.77 ± 1.51	550
14 (b)	3.61 ± 0.22	0.57 ± 0.01	0.68 ± 0.01	1.401 ± 0.090	16.59 ± 0.93	44.40 ± 1.20	520
15 (a)	3.37 ± 0.07	0.56 ± 0.02	0.66 ± 0.04	1.397 ± 0.003	15.49 ± 2.32	43.12 ± 1.12	580
16 (1)	3.69 ± 0.19	0.57 ± 0.01	0.68 ± 0.01	1.482 ± 0.067	15.77 ± 0.93	45.52 ± 2.07	530

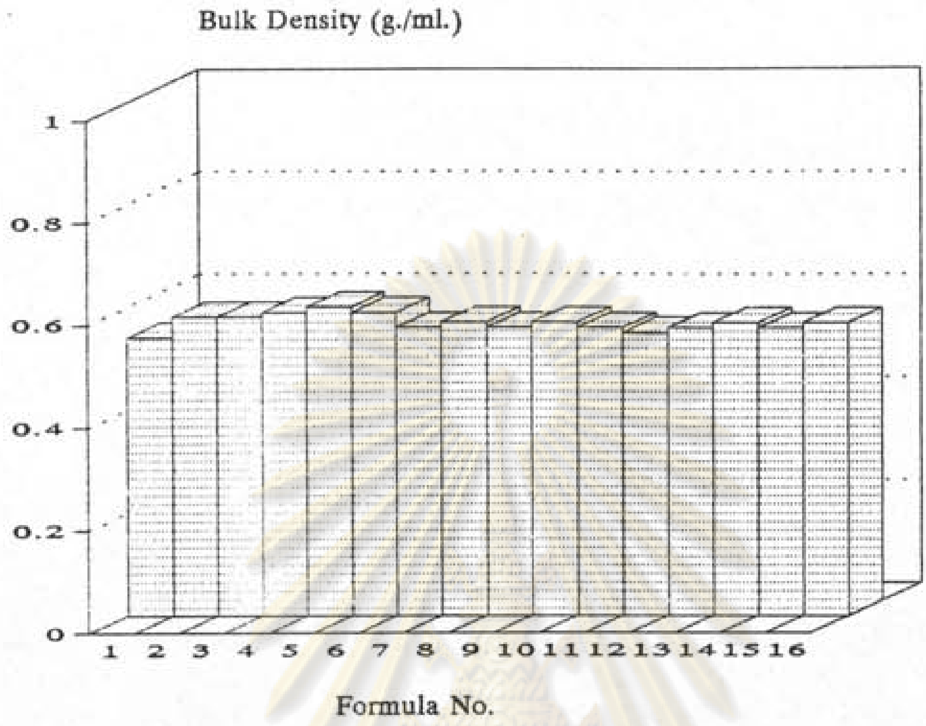

Figure 3-8 Histogram for Bulk Density of 16 Granule Formulations

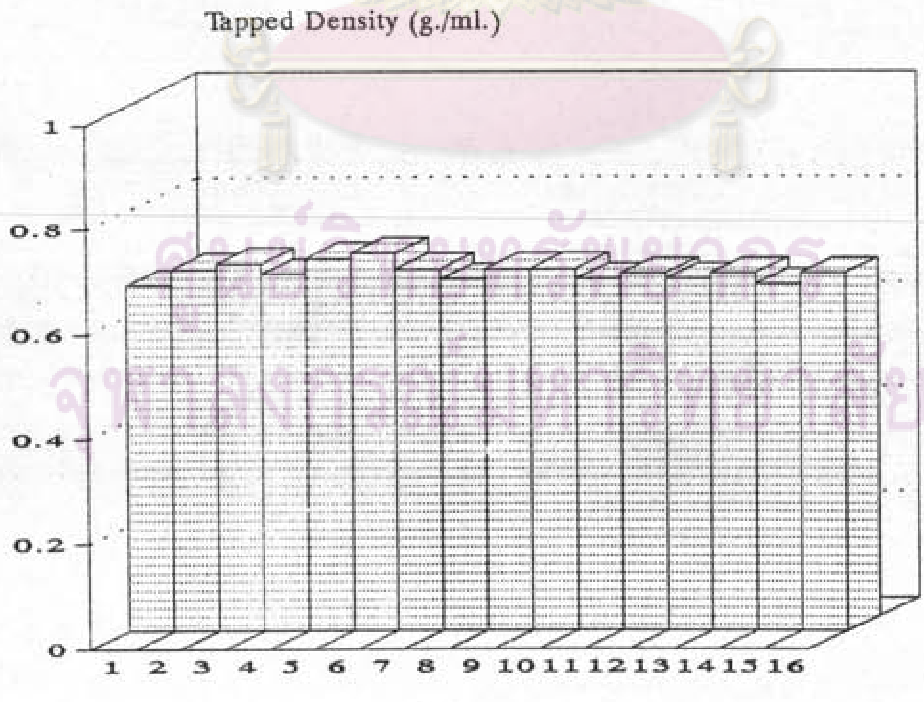

Figure 3-9 Histogram for Tapped Density of 16 Granule Formulations

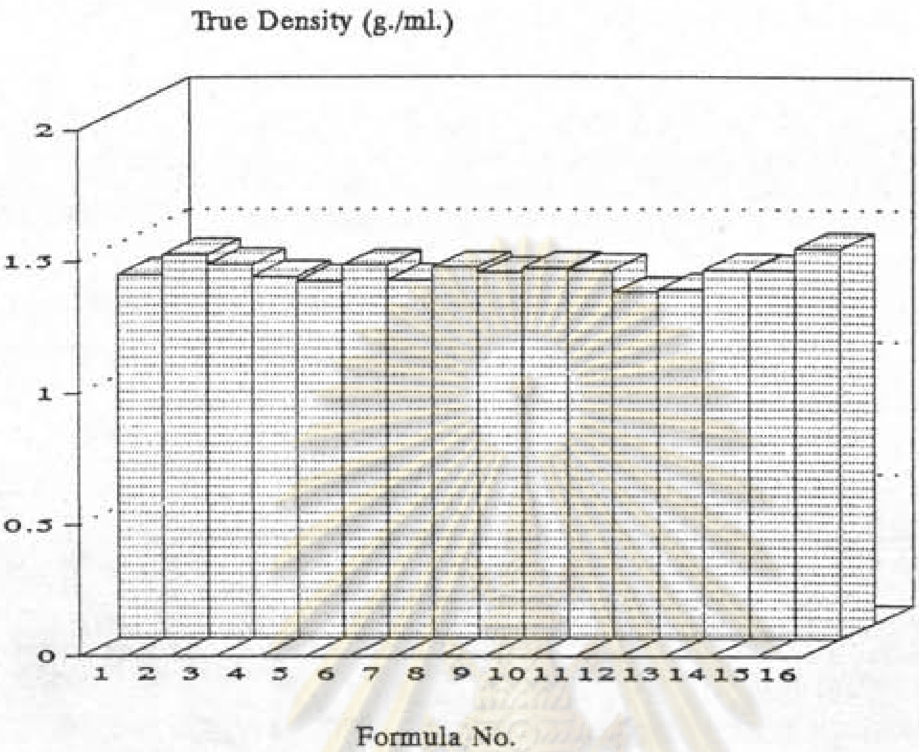

Figure 3-10 Histogram for True Density of 16 Granule Formulations

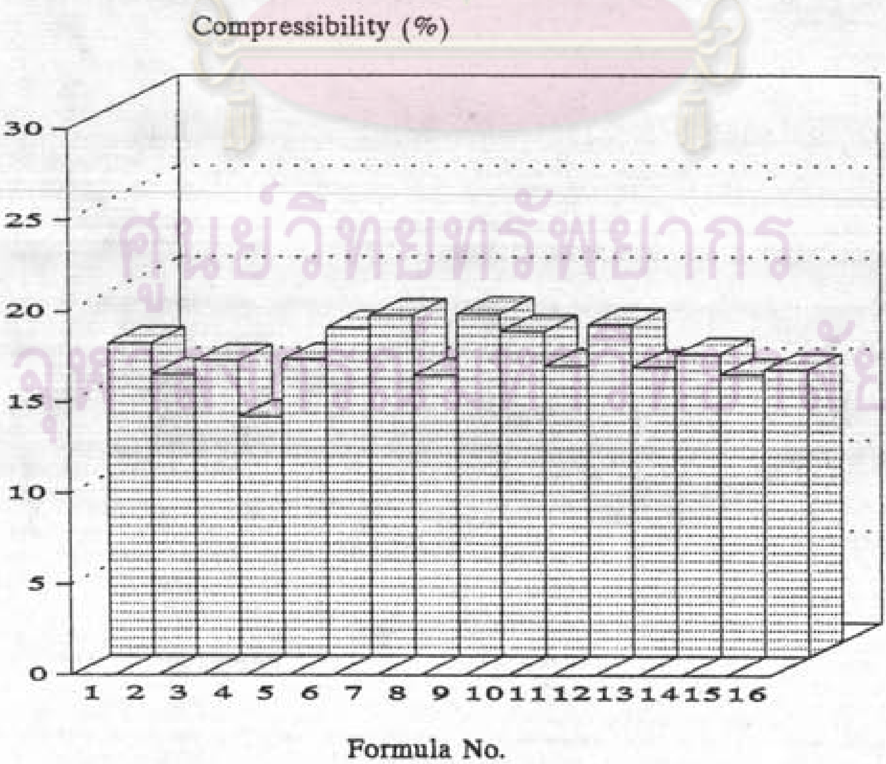

Figure 3-11 Histogram for Percent Compressibility of 16 Granule Formulations

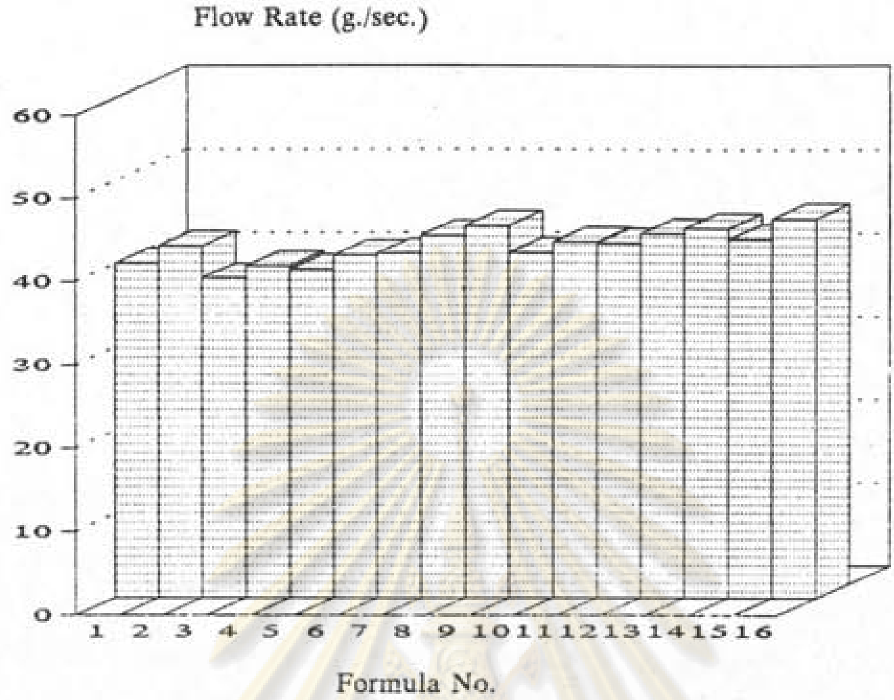

Figure 3-12 Histogram for Flow Rate of 16 Granule Formulations

Table 3-4 Physical Properties of Freshly Prepared Yeast Extract Tablets

Formula No.		Weight ± S.D. (mg./tab.)	%C.V.of Weight	%Friability	D.T.± S.D. (min.)	Hardness±S.D. (kg.)	Thickness±S.D. (mm.)	%C.V.of Thickness
1	(abcd)	339.1 ± 12.9	3.80	0.45	20.49 ± 1.66	6.8 ± 0.9	3.70 ± 0.07	1.89
2	(bcd)	364.2 ± 6.2	1.70	0.14	17.54 ± 2.89	6.6 ± 1.7	3.93 ± 0.07	1.78
3	(acd)	374.6 ± 6.5	1.74	0.06	14.78 ± 0.00	5.4 ± 0.9	4.10 ± 0.08	1.95
4	(cd)	343.2 ± 8.6	2.51	-0.39	16.28 ± 0.41	5.8 ± 0.9	3.76 ± 0.10	2.66
5	(abd)	349.0 ± 11.0	3.15	0.20	19.02 ± 5.62	7.4 ± 0.8	3.69 ± 0.15	4.06
6	(bd)	332.3 ± 7.4	2.23	0.06	18.82 ± 1.17	6.8 ± 1.1	3.57 ± 0.06	1.68
7	(ad)	345.2 ± 7.0	2.03	0.13	19.49 ± 4.02	8.4 ± 1.6	3.65 ± 0.06	1.64
8	(d)	332.0 ± 8.0	2.41	0.21	17.19 ± 0.08	7.8 ± 1.2	3.54 ± 0.09	2.54
9	(abc)	352.0 ± 5.1	1.45	0.32	17.77 ± 1.44	7.0 ± 0.7	3.82 ± 0.03	0.78
10	(bc)	336.0 ± 5.1	1.52	-0.17	16.56 ± 3.63	5.4 ± 1.0	3.67 ± 0.04	1.09
11	(ac)	342.1 ± 7.1	2.08	0.12	18.50 ± 0.88	6.4 ± 1.2	3.73 ± 0.06	1.61
12	(c)	328.3 ± 4.7	1.43	0.29	14.84 ± 3.73	6.6 ± 1.2	3.68 ± 0.20	5.44
13	(ab)	342.6 ± 8.7	2.54	0.22	13.58 ± 4.49	6.5 ± 1.2	3.66 ± 0.11	3.01
14	(b)	335.8 ± 8.0	2.38	-0.06	13.67 ± 4.20	7.5 ± 1.3	3.60 ± 0.09	2.50
15	(a)	351.0 ± 10.1	2.88	-0.25	14.98 ± 4.50	9.0 ± 0.9	3.81 ± 0.05	1.31
16	(1)	324.2 ± 3.4	1.05	-0.28	13.50 ± 0.16	7.7 ± 1.1	3.46 ± 0.03	0.87

The percent coefficient of variation of tablet weight was statistically analyzed (Appendix C-1). The results show that the effects of magnesium carbonate light, corn starch paste, dried corn starch, and magnesium stearate on the percent coefficient of variation of tablet weight are not significant at 95 percent confidential level.

3.4.2 Hardness

The means with standard deviation of tablet hardness are shown in Table 3-4. As shown in Appendix C-2 statistical analysis results indicate that factor C, high-level dried corn starch, is the significant effect.

3.4.3 Percent Friability

Percent friability is listed in Table 3-4. The results of statistical analysis are shown in Appendix C-3. The effects of magnesium carbonate light, corn starch paste, dried corn starch, and magnesium stearate on the percent friability of the yeast extract tablet are not significant at 95 percent confidential level. Each formulation of the yeast extract tablet possessed the percent friability less than 0.8 percent which meets the requirement of the standard adopted in pharmaceutical industry.

3.4.4 Thickness

The average, standard deviation, and percent coefficient of variation of tablet thickness are given in Table 3-4. The percent coefficient of variation was statistically analyzed (Appendix C-4).

The result shows that factor BC interactive effect, high concentration of corn starch paste together with high amount of dried corn starch, on percent coefficient of variation of thickness at 95 percent confidential level is significant. The percent coefficient of variation of most of thickness except for formula No.12 are within ± 5 percent which is the standard adopted in pharmaceutical industry.

3.4.5 Disintegration Time

The means with standard deviation of tablet disintegration time were presented in Table 3-4. The results of statistical analysis as shown in Appendix C-5 indicate that factor D, high-level magnesium stearate, and factor CD, high-level dried corn starch together with high-level magnesium stearate, are significant at 95% confidential level. Each formulation of the yeast extract tablets possessed the disintegration time within 30 minutes which meets the USP XXII requirement for uncoated tablet.

3.5 Salmonella Test

The examinations of *Salmonella* in the yeast extract powder and selected yeast extract tablets were terminated at the presumptive identification step. The results from both tests were negative.

3.6 Aging Studies

3.6.1 Aging in Closed Containers

3.6.1.1 Weight Variation

The results of weight variation of the yeast extract tablet after storage in closed containers for three months under various conditions are presented in Appendix D. Comparing the result within each formulation, most of them show little weight change except for formula No.12 which its weight variation did not meet the USP XXII standard.

The results of statistical analysis showed that weight changes of formulation No. 2-9, 11, 13, and 15 were not significantly affected by the aging periods at 95% confidential level. The aging periods effected significantly on weight changes of formula No.1 and No.14 at 30% RH and 70% RH conditions, formula No.10 at 50% RH, and formula No.12 and No.16 at all three conditions (α=0.05).

3.6.1.2 Hardness

The results of hardness of yeast extract tablets after storage for 3 months under various conditions are shown in Appendix D. They all showed apparently no change in hardness during the aging periods.

The statistical results showed that hardness of formula No.2-4, and No.12-15 were not significantly affected by aging periods at all conditions (α=0.05). The aging periods were the significant effects on hardness of formula No.1 at 50% RH condition, formula No. 3, 7, 9, and 16 at 30% RH, formula No.5 at all aging conditions formula No.6 and No.11 at 70% RH , formula No.8 at 50% RH and 70% RH, and formula No.10 at 30% and 70% RH conditions (α=0.05).

3.6.1.3 Thickness

The results of tablet thickness are presented in Appendix D. All the yeast extract tablets show no significant thickness change.

The results of statistical analysis at 95% confidential level showed that thickness of formula No.1-8, 10-13, and 15 were not significantly affected by the aging periods at all conditions. Aging periods affected thickness of formula No.9 at three conditions, formula No.14 at 30% RH and at 50% RH, and formula No.16 at 30% RH condition (α=0.05).

3.6.1.4 Disintegrantion Time

The results of disintegration time of yeast extract tablets after storage are shown in Appendix D. They all show obvious disintegration time fluctuation.

The statistical results at 95% confidential level showed that disintegration time of formula No.2, 4, 7, and 12 were not significantly affected at every conditions by the aging periods. The aging periods effected on disintegration time of formula No.1 and No.15 at every storage conditions, formula No. 3, 5, and 9 at 30% RH, formula No.6 and No.13 at 50% RH, formula No.8 at 70% RH, formula No.10, 14, and 16 at 30% RH and 50% RH, and formula No.11 at 30% RH and 70% RH conditions ($\alpha=0.05$).

3.6.2. Aging in Opened Containers

3.6.2.1 Appearance of the Yeast Extract Tablets

As shown in Figure 3-13 to 3-15 during the first week of the study, tablets stored at the 70% relative humidity showed a mottling on their surface and a week later, color of the tablets were different from the initial tablets. The tablets clearly changed in color within 4 weeks and followed by a loss of lustre on the surface. At the 50 percent relative humidity condition, tablets showed a small degree of color change within 2 weeks. The mottling was seen after 2 weeks. Tablets stored at the 30 percent relative humidity did not exhibit any visual changes over a 30 day period.

3.6.2.2 Weight Variation

Changes in weight occurred in all formulations (Figure 3-16a to 3-31a). Yeast extract tablets stored at higher humidities showed larger increases in weight. The tablets stored at the 70% relative humidity exhibited rapid weight increases within one week.

The results of statistical analysis showed that the aging periods did not significantly effect on tablet weight variation of formula No.4, 7, 8, 12, 14 and 15 at the 30% RH condition ($\alpha=0.05$). The formula No.14 tablet had no significant weight change during aging at 50% RH ($\alpha=0.05$).

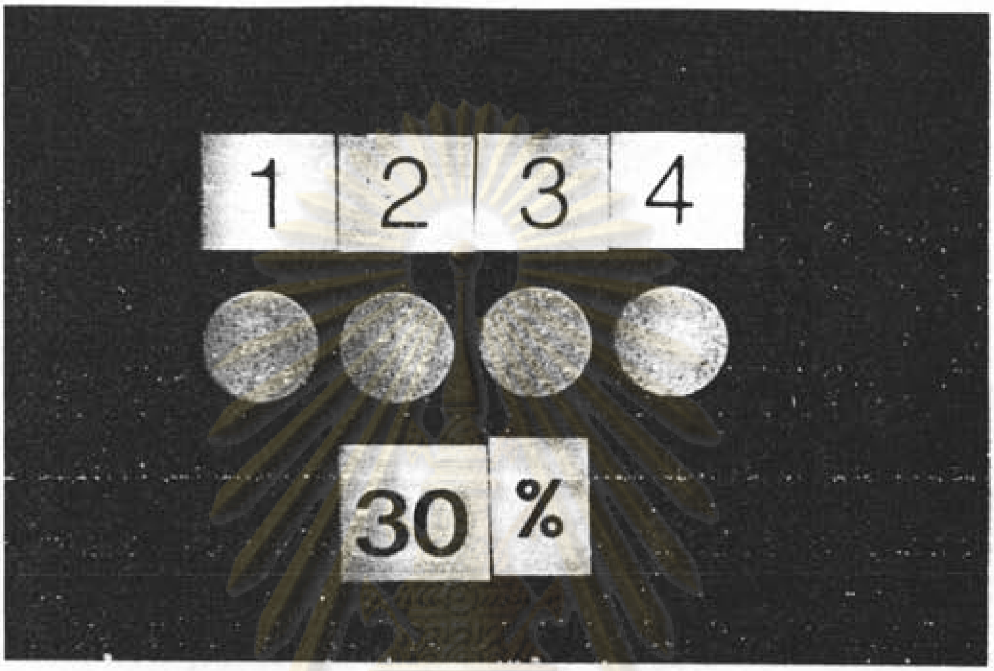

Figure 3-13 Photograph of Selected Yeast Extract Tablet After Storing in Opened Container at 30% Relative Humidity, Comparing with the Freshly Prepared Yeast Extract Tablet:

(1) Freshly prepared yeast extract tablet

(2) After storing for 7 days

(3) After storing for 15 days

(4) After storing for 30 days

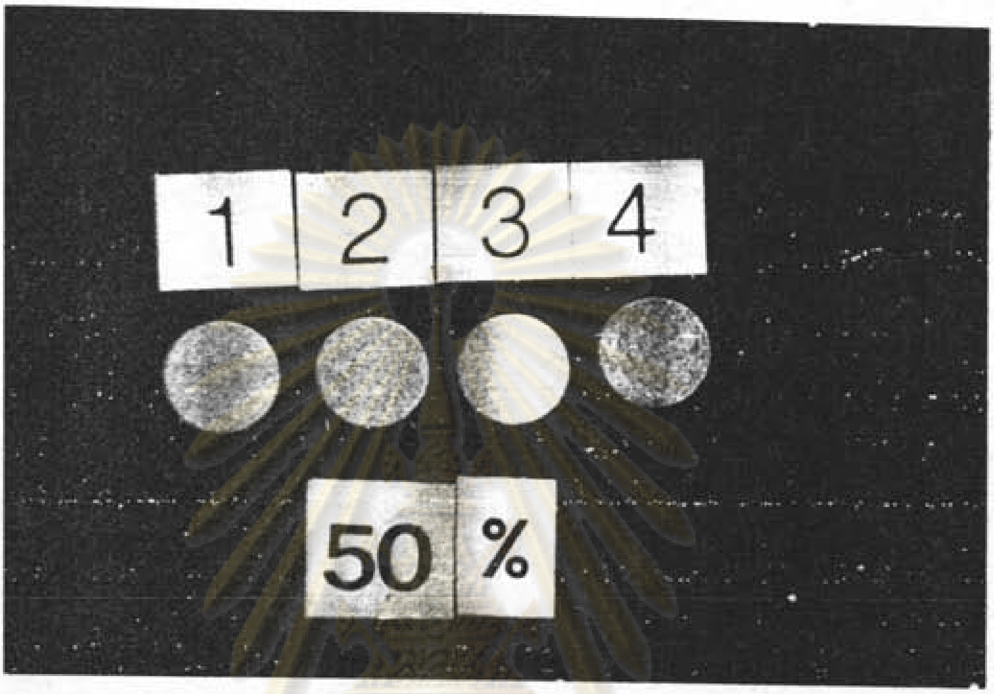

Figure 3-14 Photograph of Selected Yeast Extract Tablet After Storing in Opened Container at 50% Relative Humidity, Comparing with the Freshly Prepared Yeast Extract Tablet:

(1) Freshly prepared yeast extract tablet

(2) After storing for 7 days

(3) After storing for 15 days

(4) After storing for 30 days

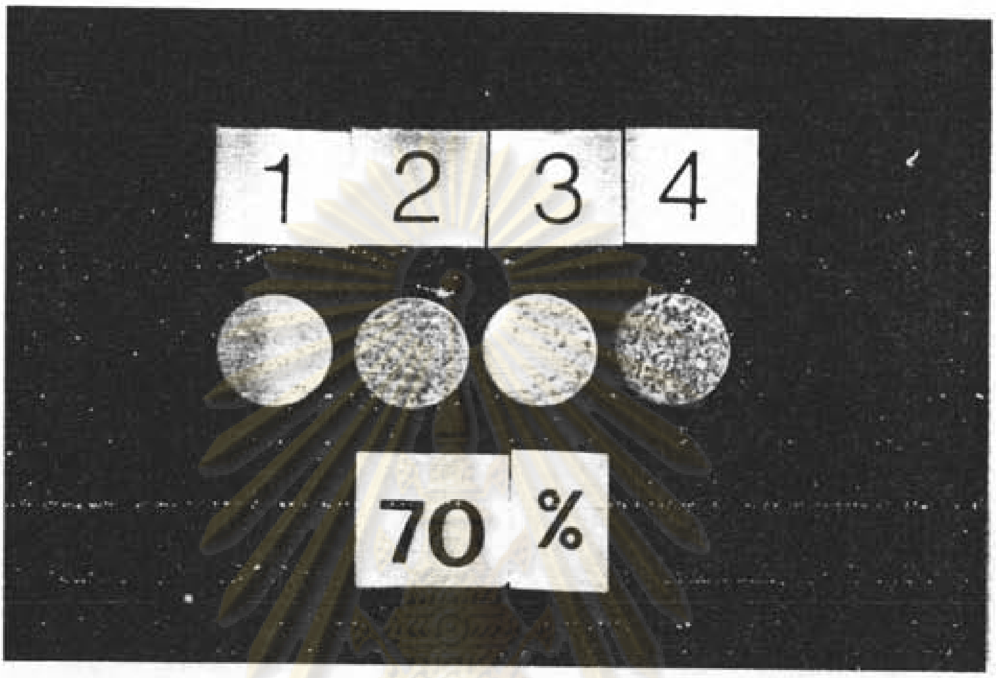

Figure 3-15 Photograph of Selected Yeast Extract Tablet After Storing in Opened Container at 70% Relative Humidity, Comparing with the Freshly Prepared Yeast Extract Tablet:

(1) Freshly prepared yeast extract tablet

(2) After storing for 7 days

(3) After storing for 15 days

(4) After storing for 30 days

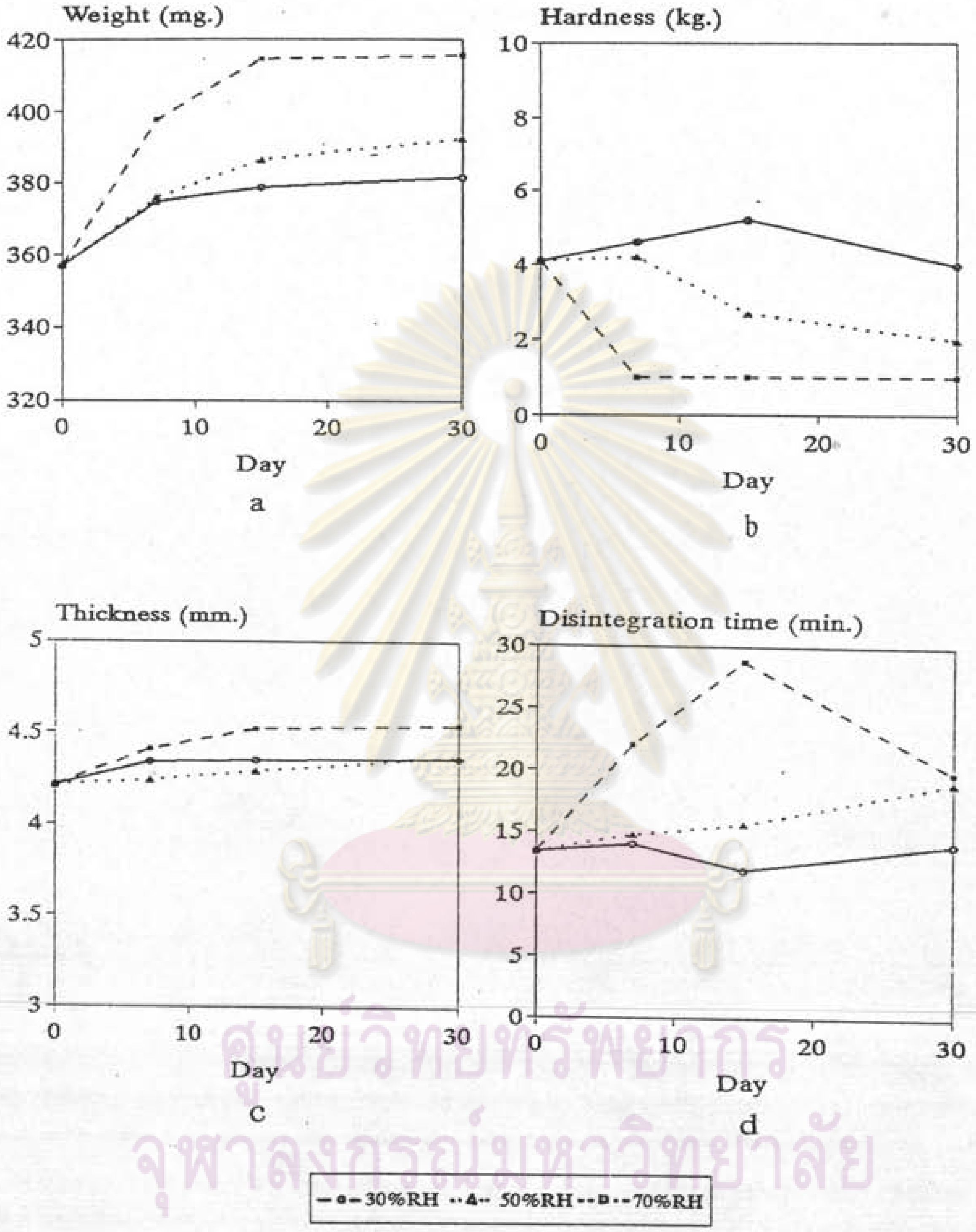

Figure 3-16 Effect of Aging Periods on (a) Weight, (b) Hardness, (c) Thickness, and (d) Disintegration Time of Yeast Extract Tablet Formula No.1 After Storing in Opened Container under Different Conditions.

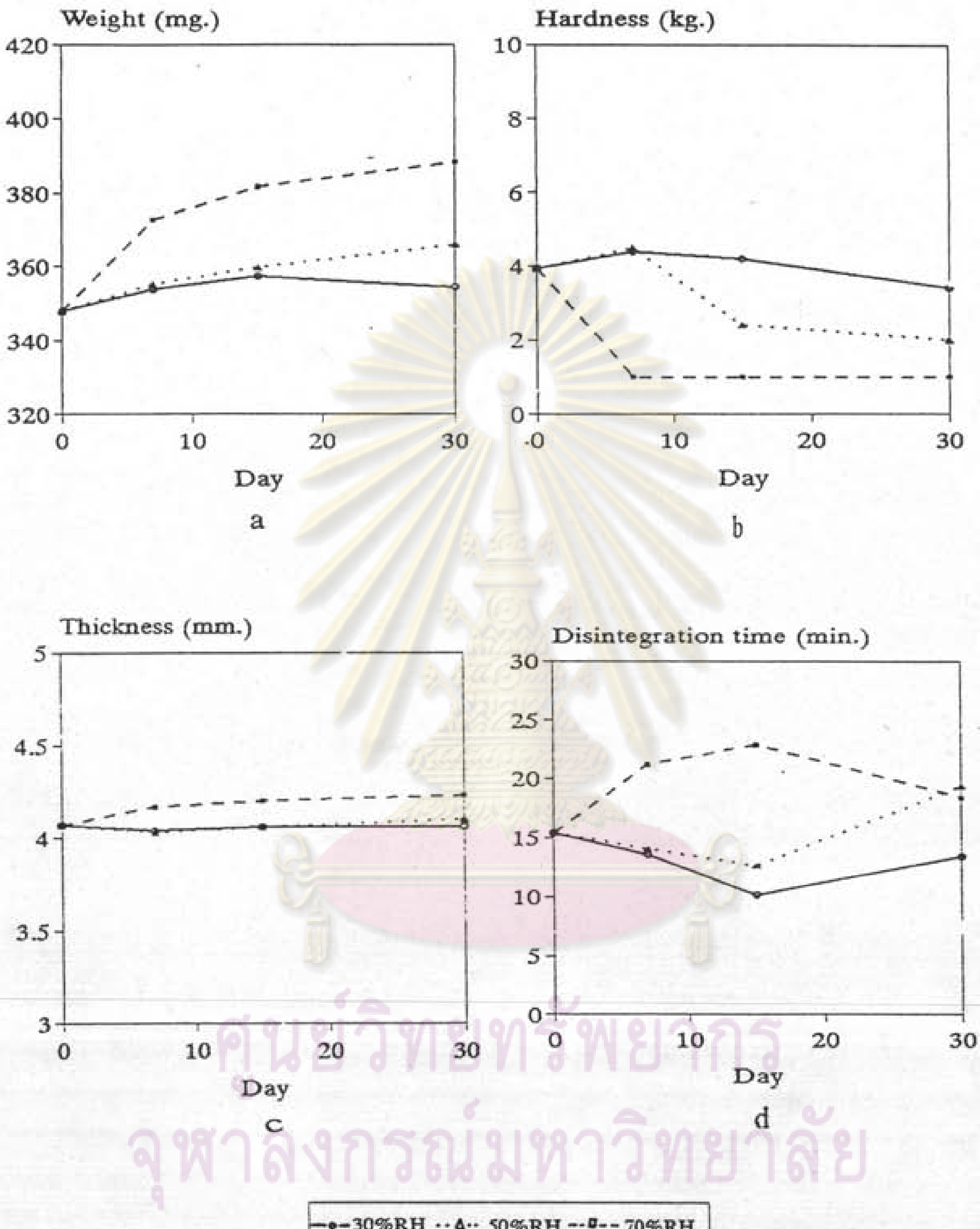

Figure 3-17 Effect of Aging Periods on (a) Weight, (b) Hardness, (c) Thickness, and (d) Disintegration Time of Yeast Extract Tablet Formula No.2 After Storing in Opened Container under Different Conditions.

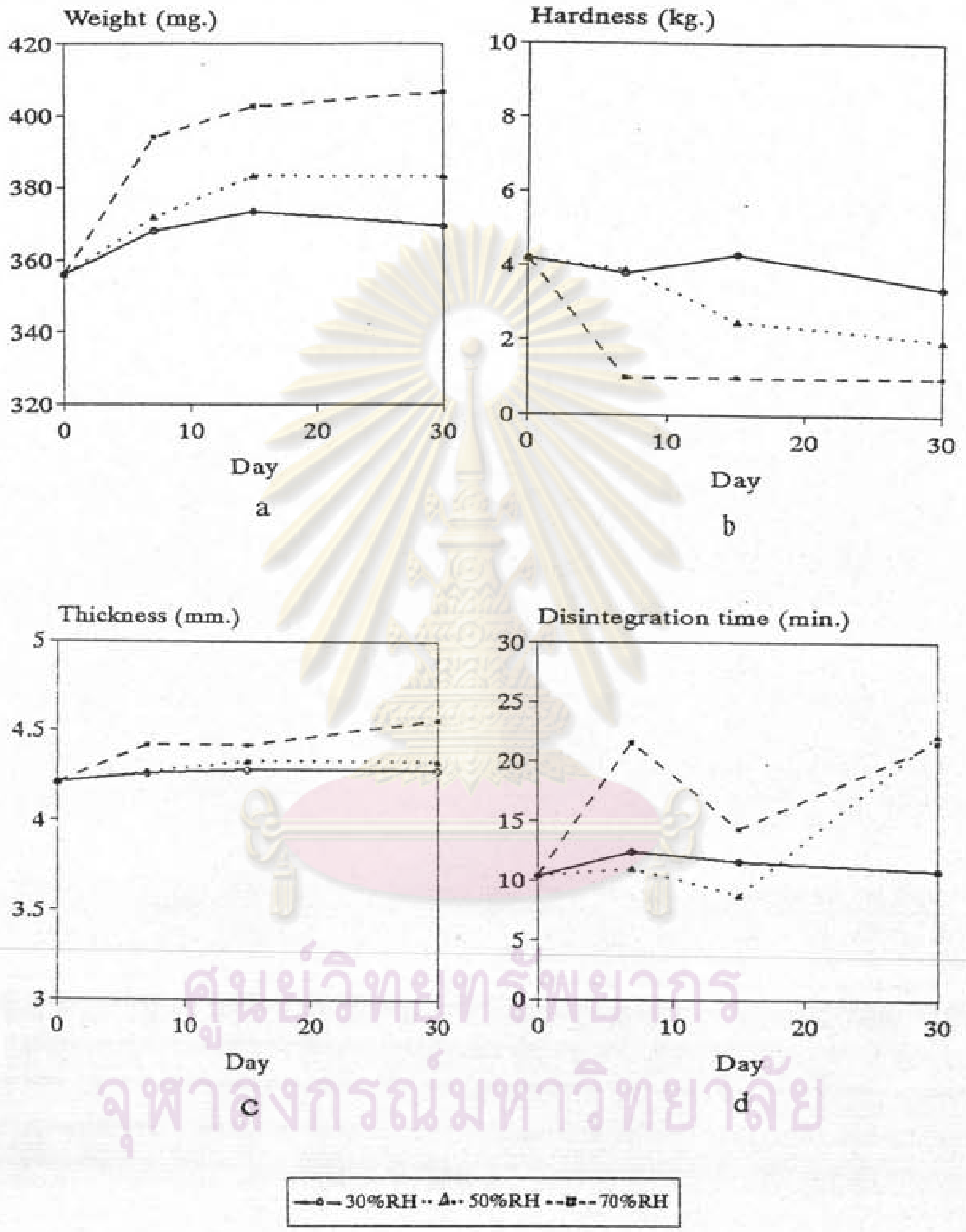

Figure 3-18 Effect of Aging Periods on (a) Weight, (b) Hardness, (c) Thickness, and (d) Disintegration Time of Yeast Extract Tablet Formula No.3 After Storing in Opened Container under Different Conditions.

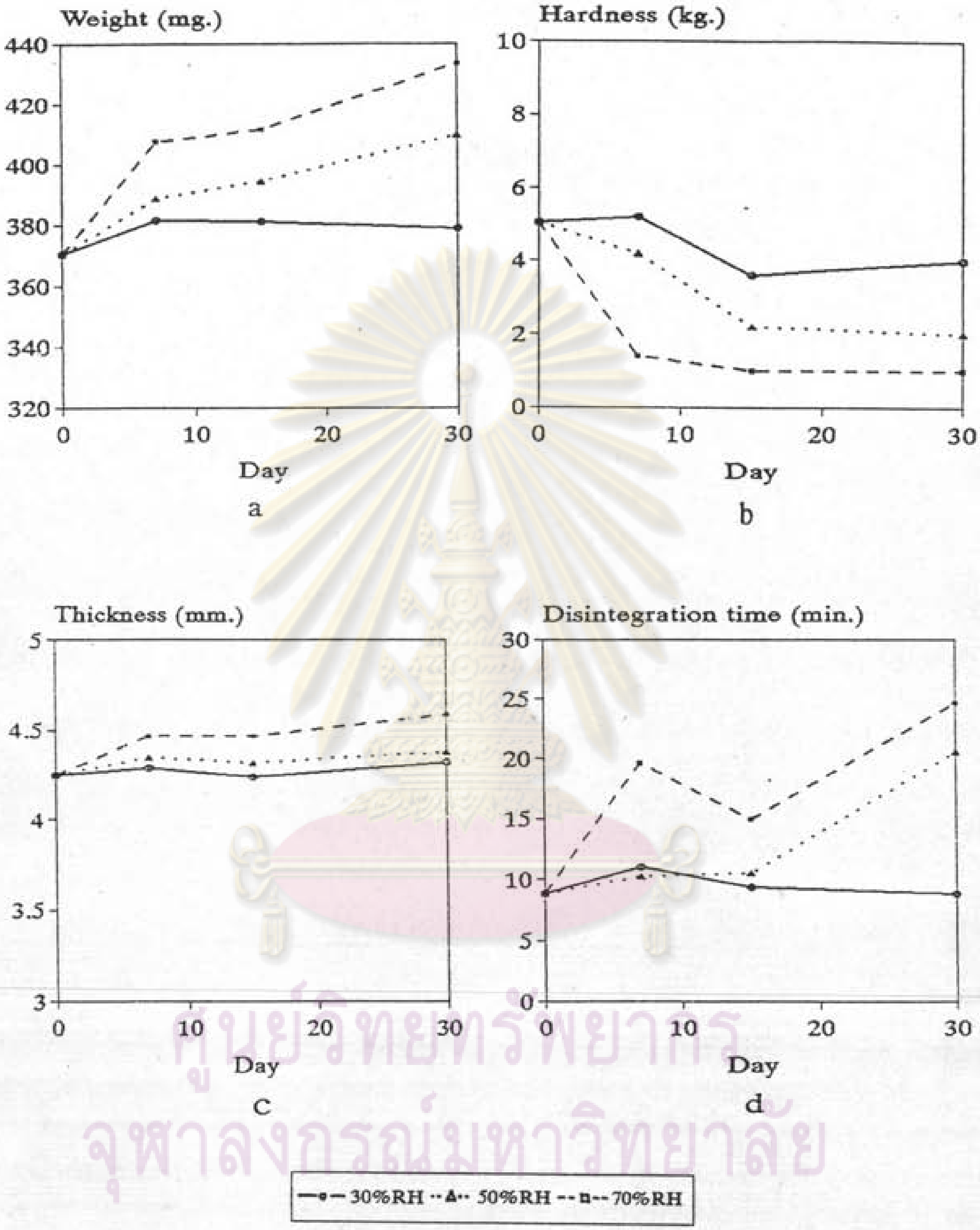

Figure 3-19 Effect of Aging Periods on (a) Weight, (b) Hardness, (c) Thickness, and (d) Disintegration Time of Yeast Extract Tablet Formula No.4 After Storing in Opened Container under Different Conditions.

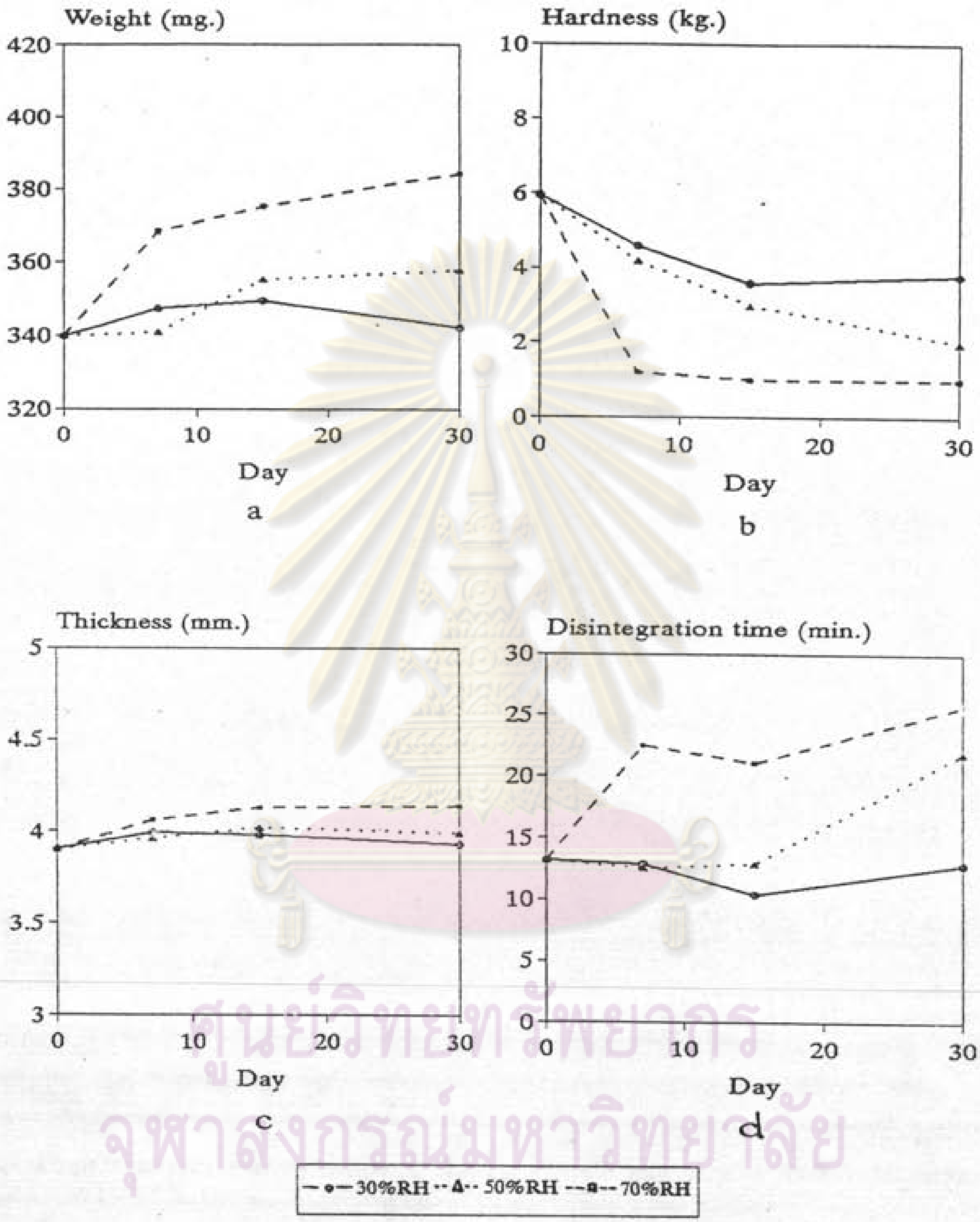

Figure 3-20 Effect of Aging Periods on (a) Weight, (b) Hardness, (c) Thickness, and (d) Disintegration Time of Yeast Extract Tablet Formula No.5 After Storing in Opened Container under Different Conditions.

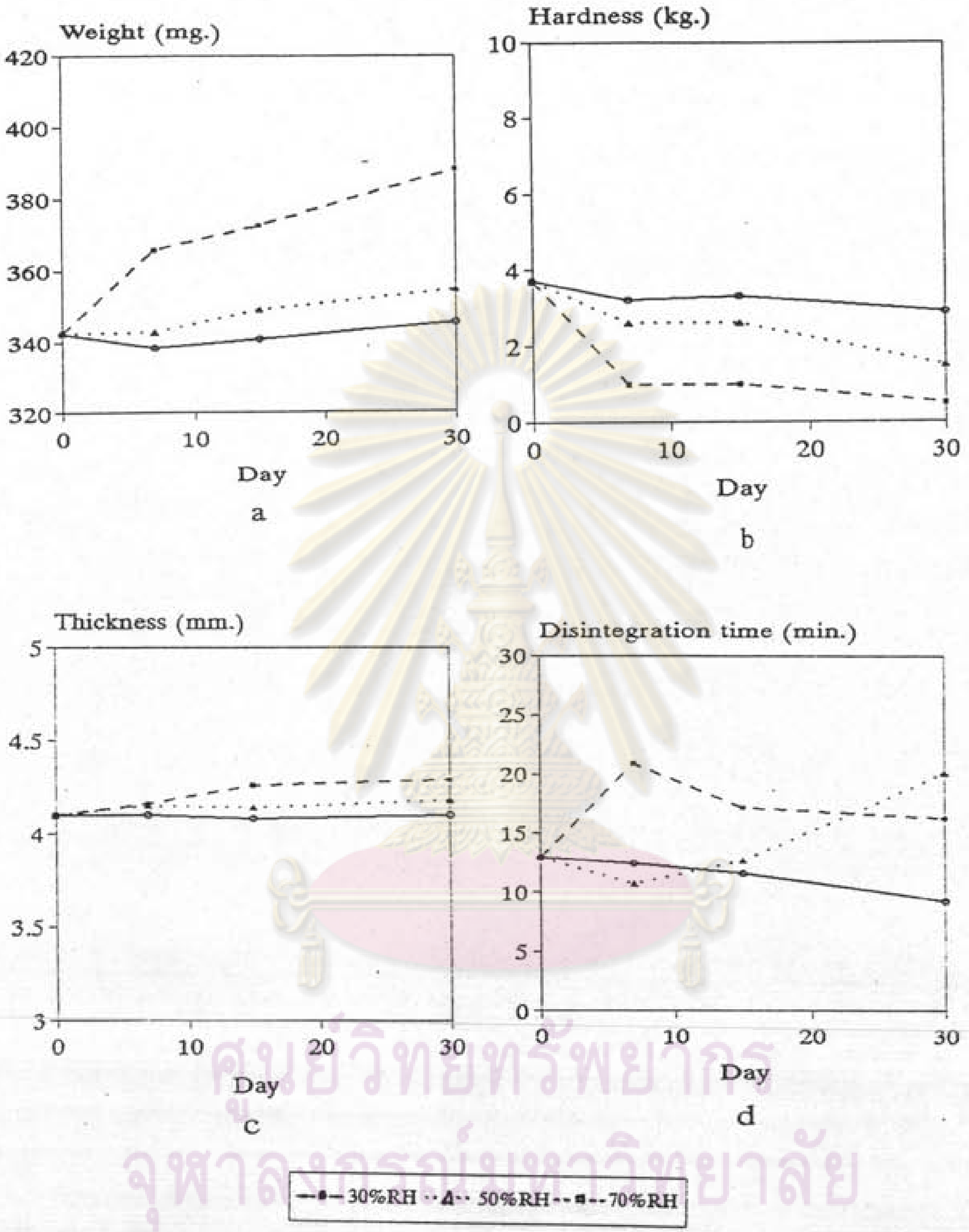

Figure 3-21 Effect of Aging Periods on (a) Weight, (b) Hardness, (c) Thickness, and (d) Disintegration Time of Yeast Extract Tablet Formula No.6 After Storing in Opened Container under Different Conditions.

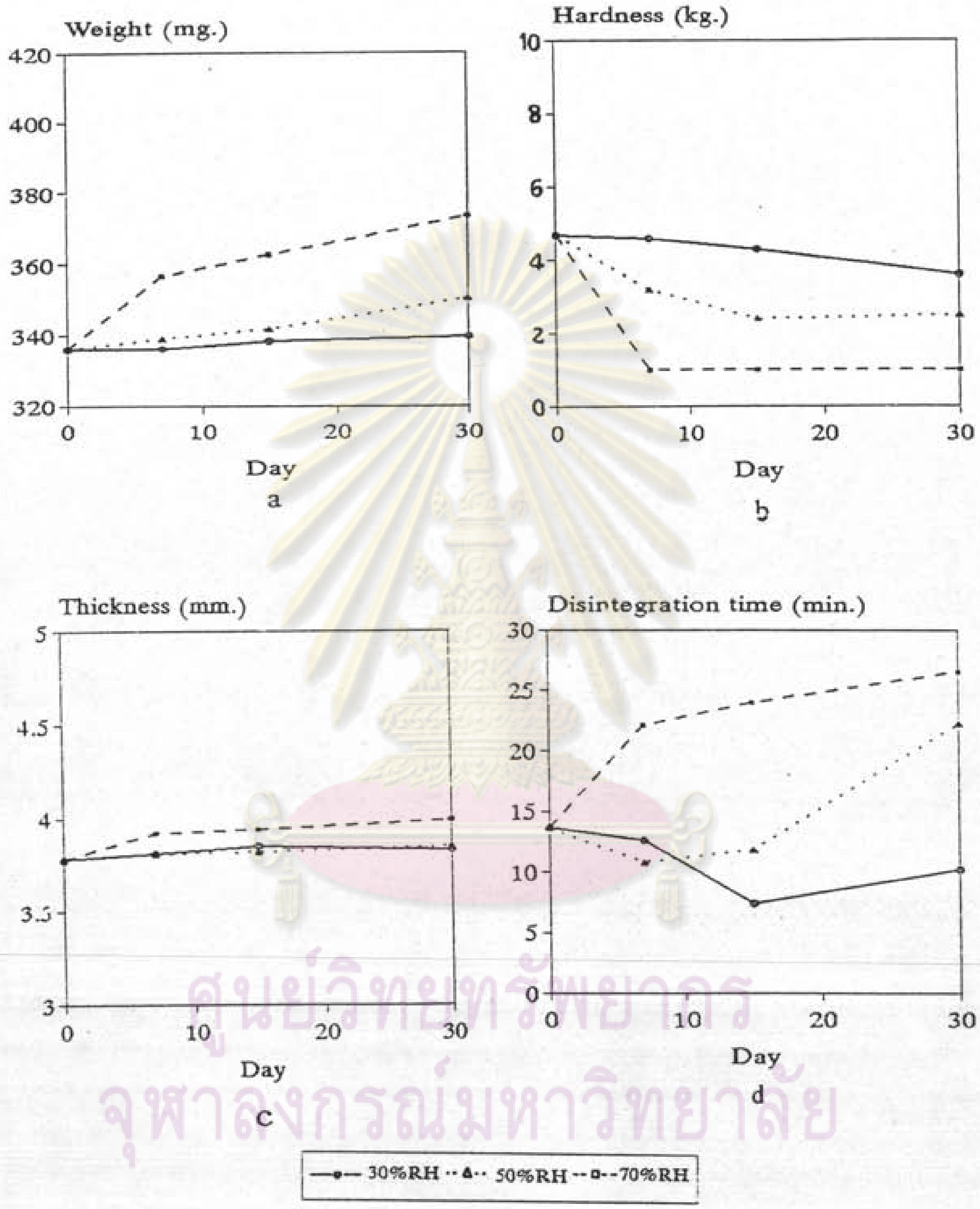

Figure 3-22 Effect of Aging Periods on (a) Weight, (b) Hardness, (c) Thickness, and (d) Disintegration Time of Yeast Extract Tablet Formula No.7 After Storing in Opened Container under Different Conditions.

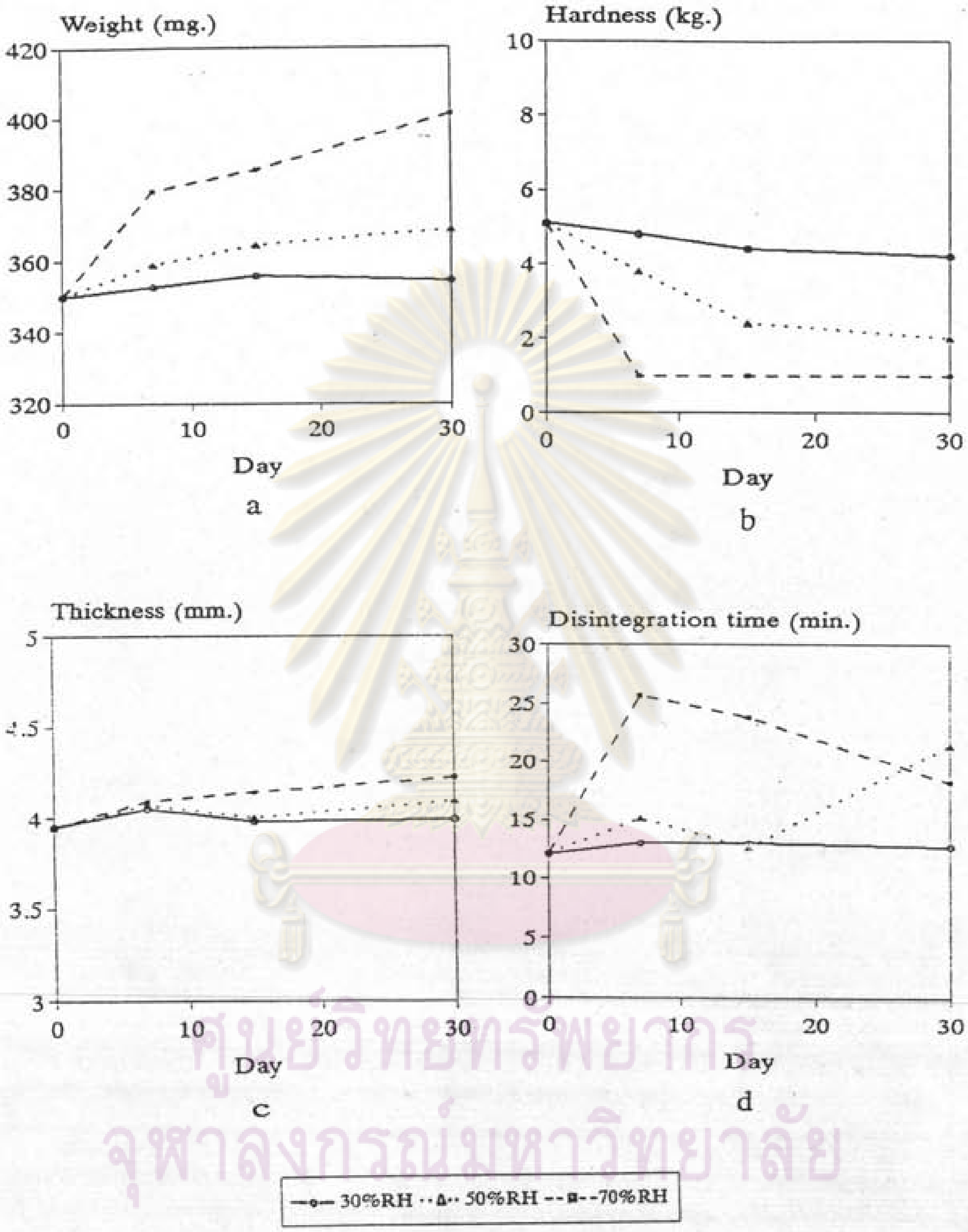

Figure 3-23 Effect of Aging Periods on (a) Weight, (b) Hardness, (c) Thickness, and (d) Disintegration Time of Yeast Extract Tablet Formula No.8 After Storing in Opened Container under Different Conditions.

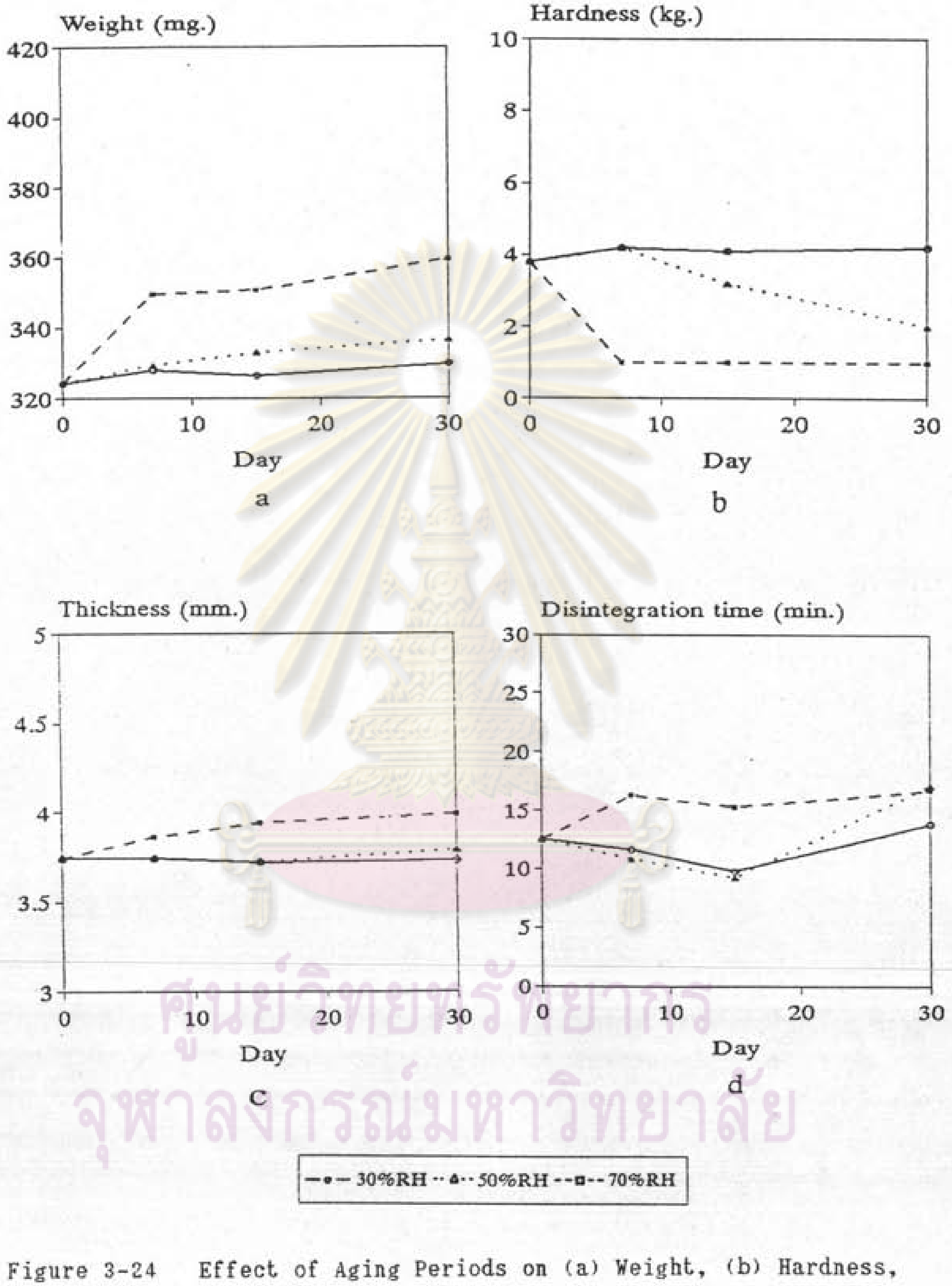

Figure 3-24 Effect of Aging Periods on (a) Weight, (b) Hardness, (c) Thickness, and (d) Disintegration Time of Yeast Extract Tablet Formula No.9 After Storing in Opened Container under Different Conditions.

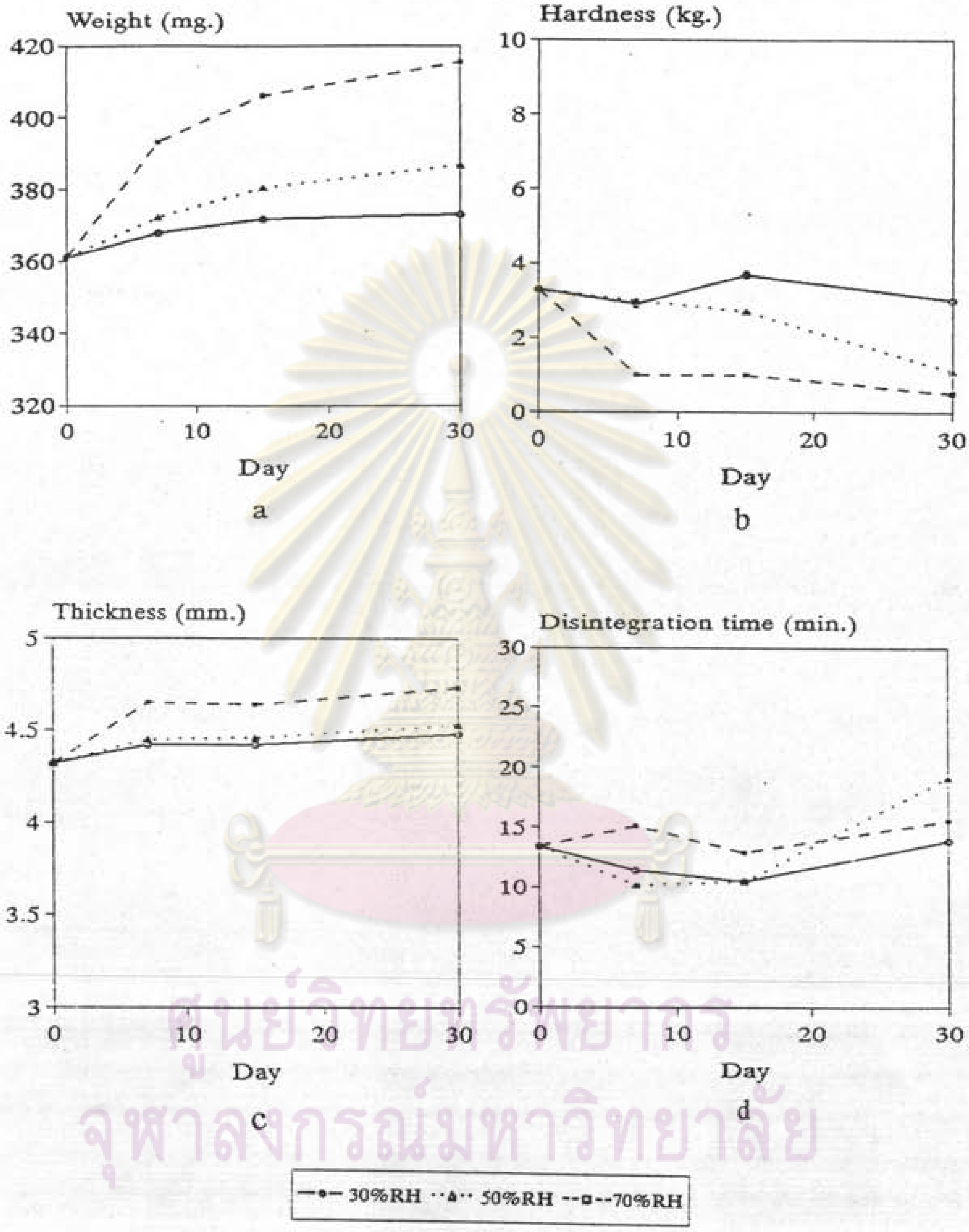

Figure 3-25 Effect of Aging Periods on (a) Weight, (b) Hardness, (c) Thickness, and (d) Disintegration Time of Yeast Extract Tablet Formula No.10 After Storing in Opened Container under Different Conditions.

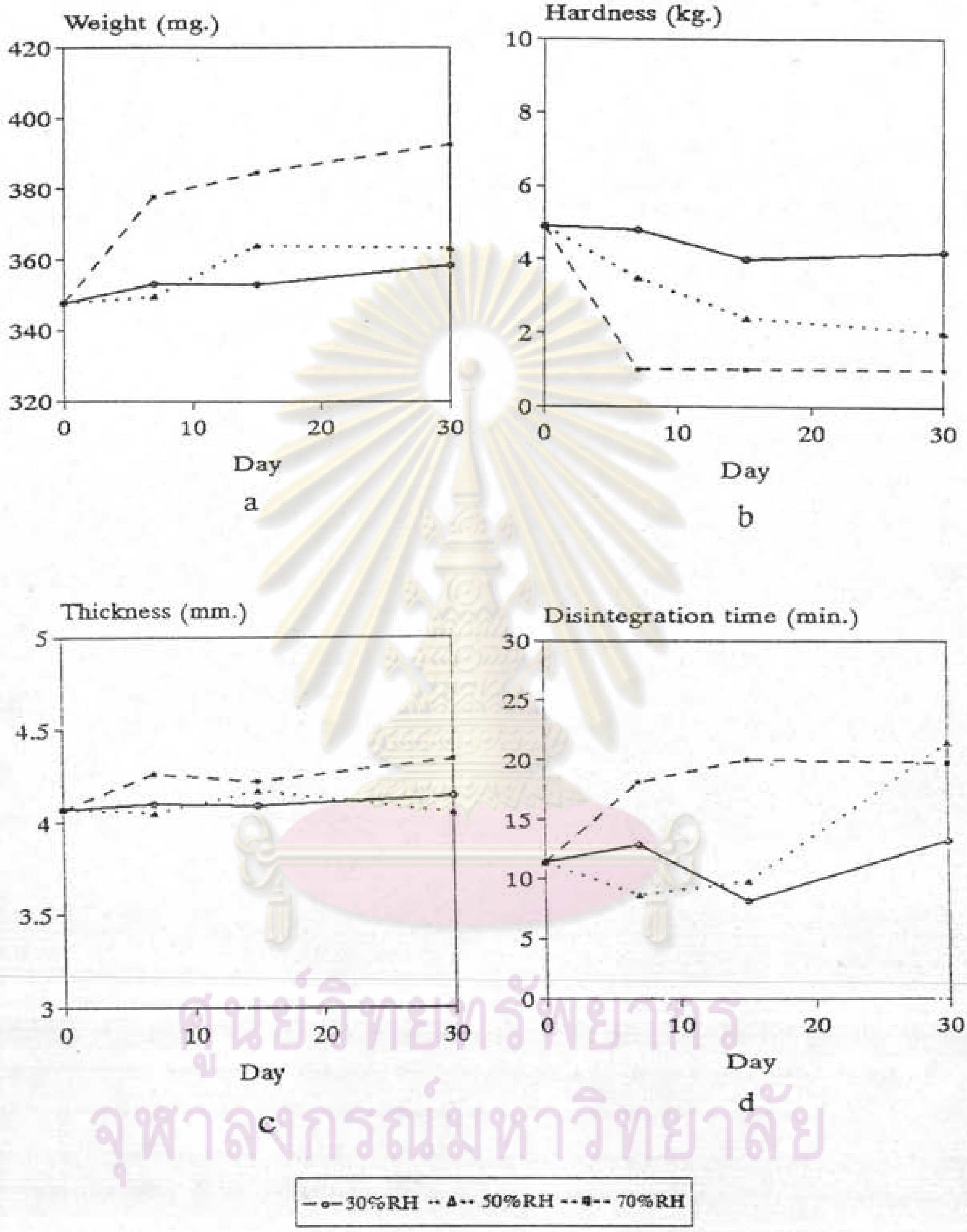

Figure 3-26 Effect of Aging Periods on (a) Weight, (b) Hardness, (c) Thickness, and (d) Disintegration Time of Yeast Extract Tablet Formula No.11 After Storing in Opened Container under Different Conditions.

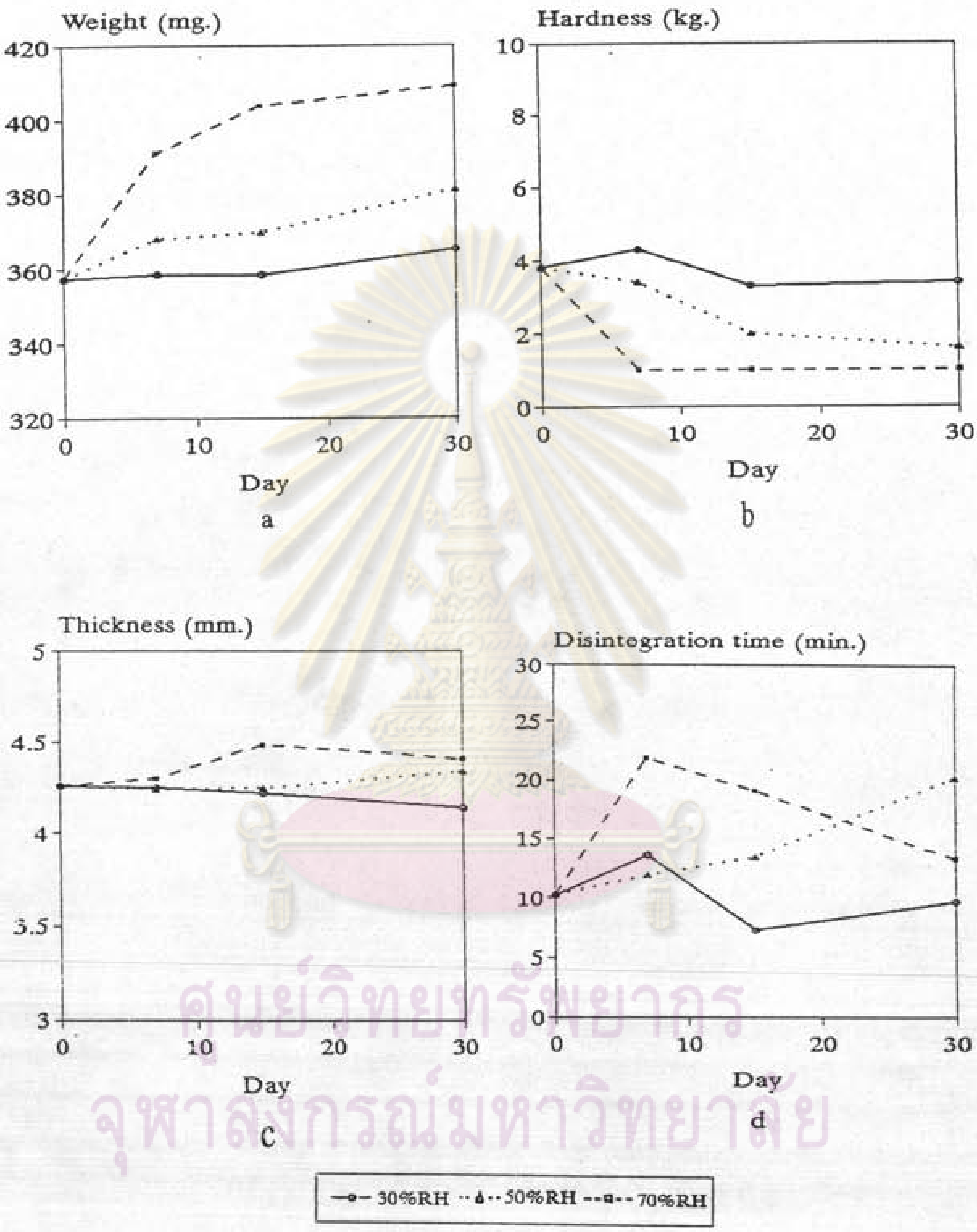

Figure 3-27 Effect of Aging Periods on (a) Weight, (b) Hardness, (c) Thickness, and (d) Disintegration Time of Yeast Extract Tablet Formula No.12 After Storing in Opened Container under Different Conditions.

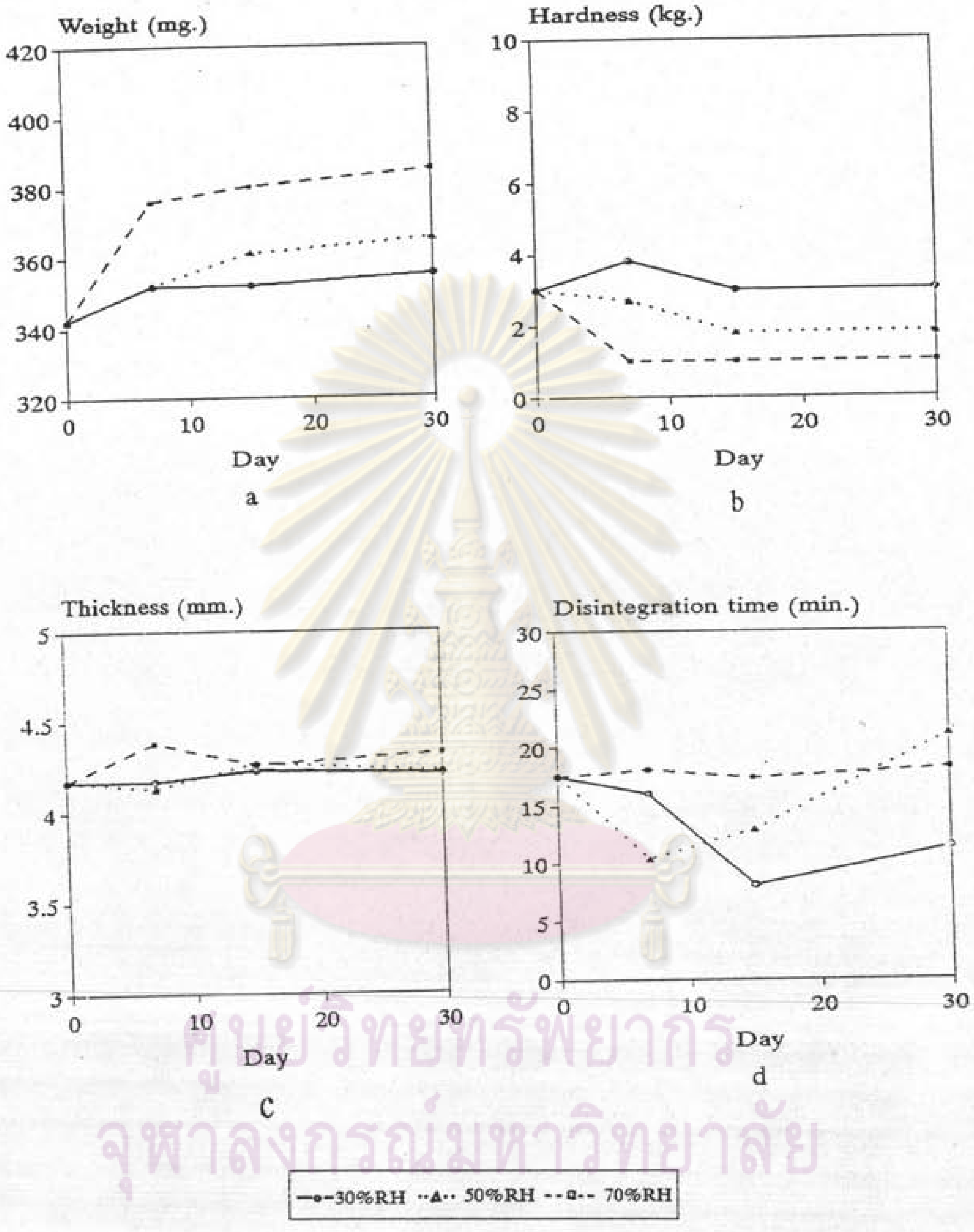

Figure 3-28 Effect of Aging Periods on (a) Weight, (b) Hardness, (c) Thickness, and (d) Disintegration Time of Yeast Extract Tablet Formula No.13 After Storing in Opened Container under Different Conditions.

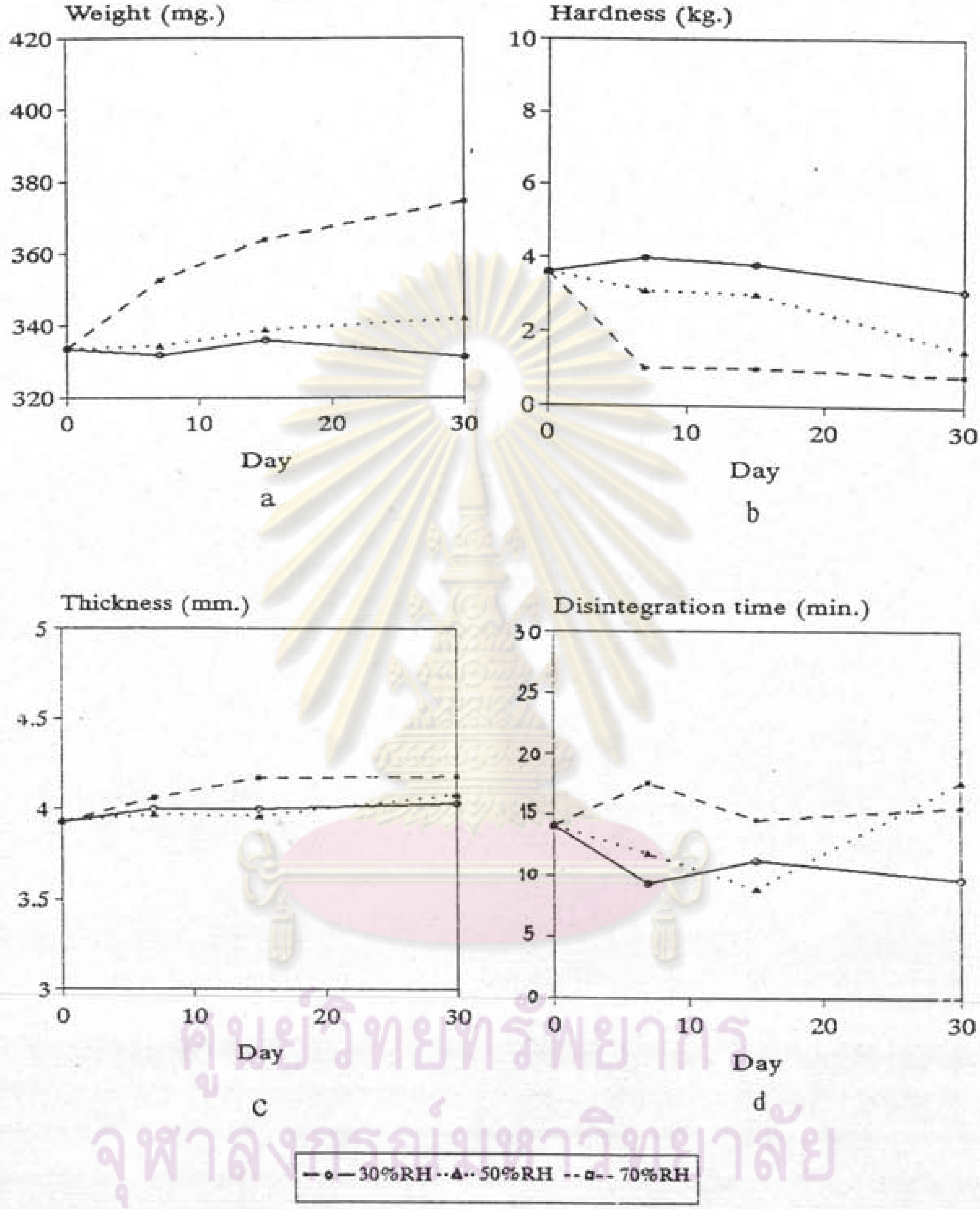

Figure 3-29 Effect of Aging Periods on (a) Weight, (b) Hardness, (c) Thickness, and (d) Disintegration Time of Yeast Extract Tablet Formula No.14 After Storing in Opened Container under Different Conditions.

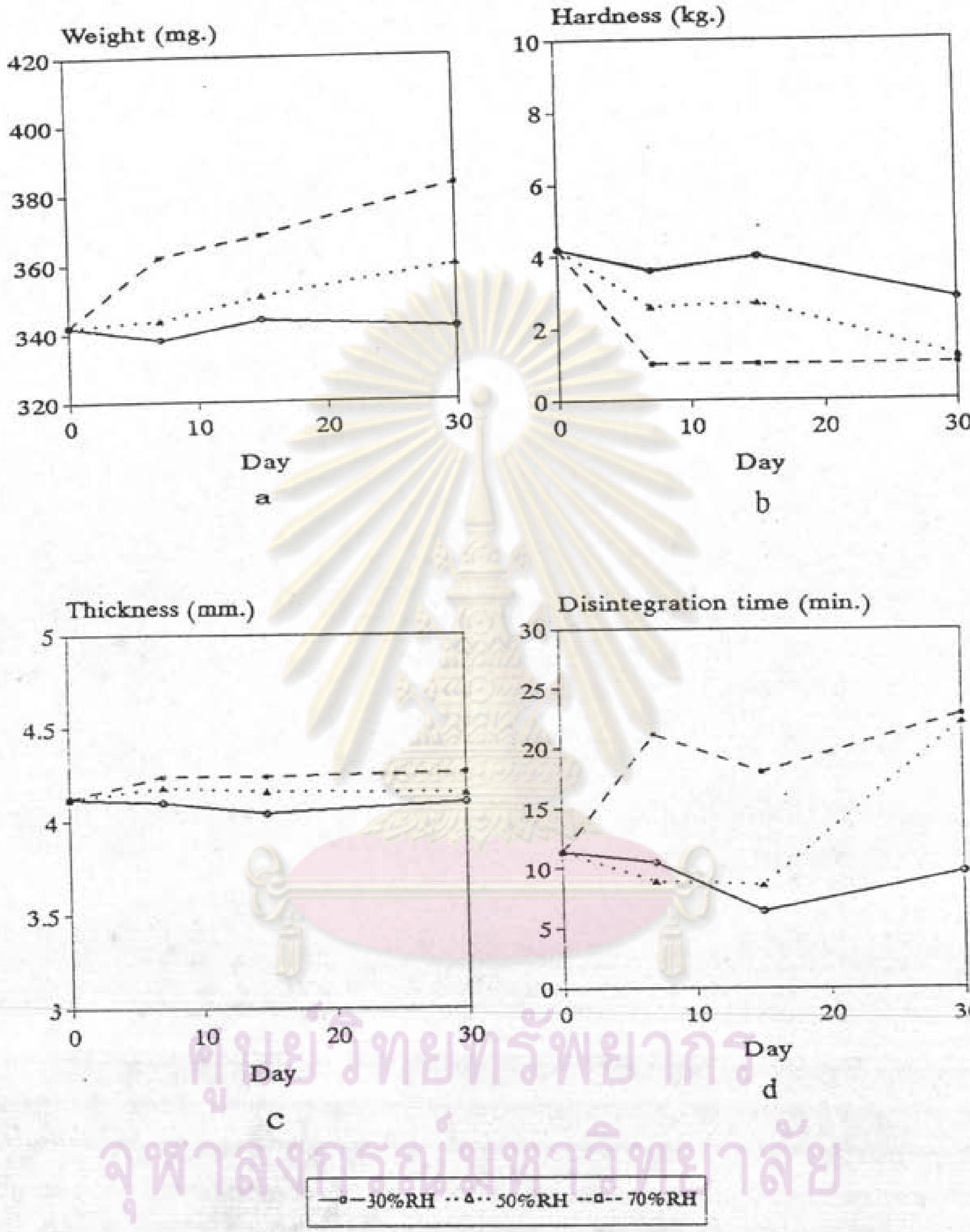

Figure 3-30 Effect of Aging Periods on (a) Weight, (b) Hardness, (c) Thickness, and (d) Disintegration Time of Yeast Extract Tablet Formula No.15 After Storing in Opened Container under Different Conditions.

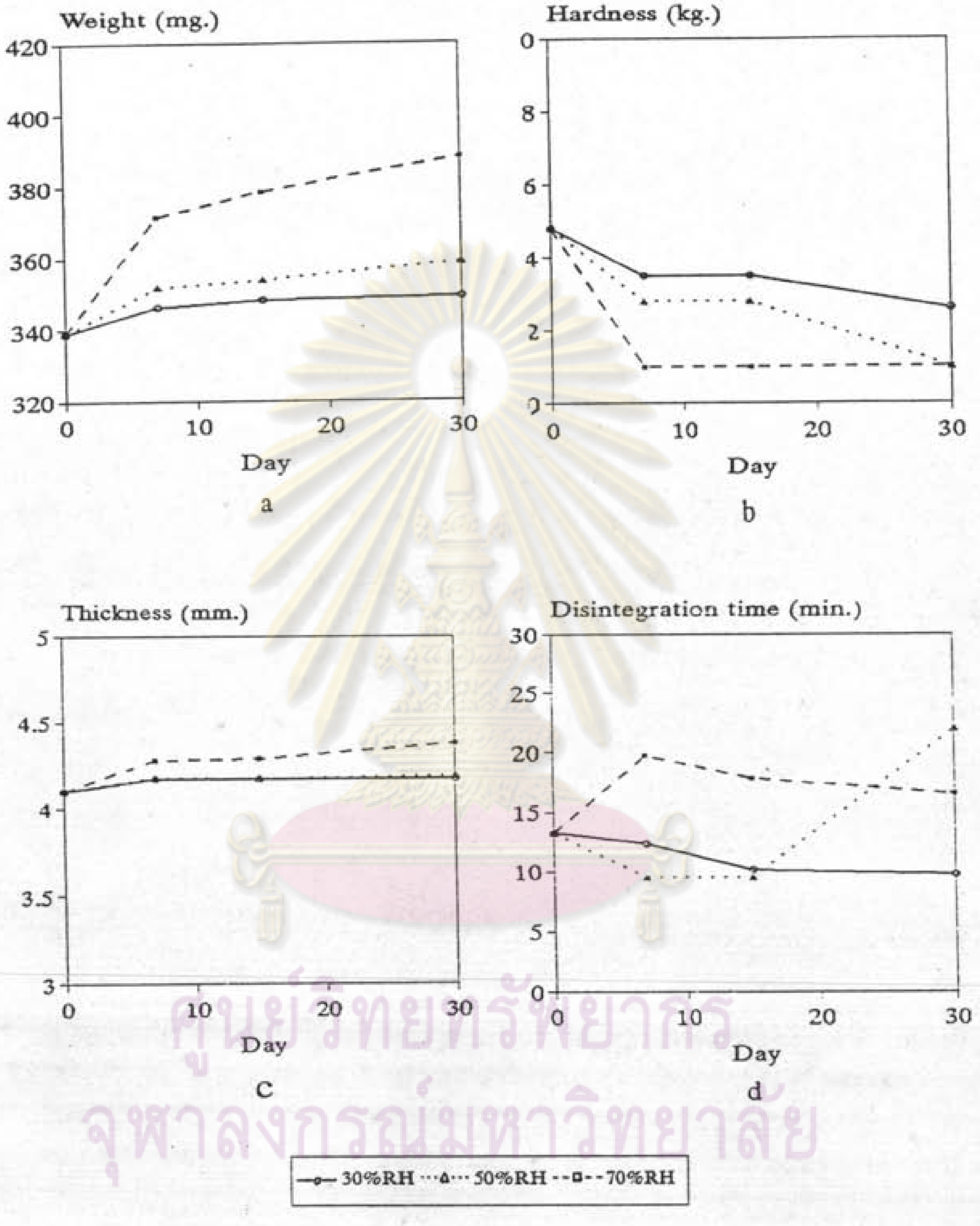

Figure 3-31 Effect of Aging Periods on (a) Weight, (b) Hardness, (c) Thickness, and (d) Disintegration Time of Yeast Extract Tablet Formula No.16 After Storing in Opened Container under Different Conditions.

3.6.2.3 Hardness

Hardness changes of yeast extract tablets are plotted and shown in Figure 3-16b to 3-31b. Most of stored tablets softened with time. Comparing with the initial hardness, tablets of formulation No. 5, 6, 15, and 16 from 30 percent relative humidity condition showed apparently decreases in hardness throughout the aging periods whereas tablets of the other formulations presented increases in hardness during the first week except for formula No.4 and 10. At 50 percent relative humidity condition, tablets of formula No.1, 2, and 9 were shown increasing hardness within one week after that the tablet hardness was decreased. Hardness decreased sharply within one week for every formulation tablets stored under 70% relative humidity condition and was observed no further change till the end of the study.

The results of statistical analysis showed that only hardness of tablet of formula No.9, stored under 30% RH condition, was not significantly affected by the aging periods at 95% confidential level.

3.6.2.4 Thickness

Figure 3-16c to 3-31c show results of thickness variation of yeast extract tablets during aging. At 30 percent relative humidity and 50 percent relative humidity condition, thickness of tablet was slightly changed comparing with the initial thickness. At 70 percent relative humidity, thickness was slowly increased.

The statistical results at 95% confidential level of each formula showed that thickness of every formulation tablets were significantly affected by the aging periods at 70% RH. The aging periods nonsignificantly effected at 95% confidential level on thickness of formula No.2, 4, 9, 12, 14, and 15 at 50% RH condition. At 30% RH , thickness of formula No.2-4, 6, 8, 9, 11, 12, 14, and 15 were not significantly affected at 95% confidential level.

3.6.2.5 <u>Disintegration Time</u>

An evaluation of disintegration time showed very complex changes over the study period (Figure 3-13d to 3-31d). At 70 percent relative humidity condition, disintegration time increased within the first week. At the second week, formula No.1 and 2 tablets showed increases in disintegration time then decreases two weeks later whereas formula No.3-5, 9, 10, and 13-15 showed the contrary results. After one week, disintegration times of formula No.6, 8, 12, and 16 were decreased whereas the adversed results occurred for formula No.7 and 11. All formulations showed increases in disintegration time at the 50 percent relative humidity after 2 week storage. At 30 percent relative humidity disintegration time almost showed no change.

The results of statistical analysis show that the aging periods did not significantly effect on disintegration time of tablets except for formula No. 7 and 12-14 at 30% RH condition (α=0.05). At 50% RH, disintegration time of tablets was significantly affected at 95% confidential level except for formula No. 1 and 2.

Disintegration time of almost all formulations at 70% RH condition was significantly affected at 95% confidential level except for formula No. 9.