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APPENDICES

Appendix I

Calculation of Degree of Subsitution

Determination of degree of substitution

(Method of calculation)

Example Sample from method A (DS ≈ 0.3)

Normality of NaOH VS. = 0.1009 N

Normality of HCl VS. = 0.1013 N

Average residue on ignition (C) = 11.74 %

Sample 1 Weight of MGS = 1.0017 gm

Volume of $NaOH_1$ (added first) = 25.0 ml

Volume of HCl used = 25.0 ml

Volume of $NaOH_2$ (for back titration) = 0.5 ml

$NaOH_2$ (= excess HCl) = 0.5×0.1009 = 0.0505 meq.

HCl used (= total HCl - excess HCl) = $(25.0 \times 0.1013) - 0.0505$ = 2.4820 meq.

excess $NaOH_1$ (react with HCl used) = 2.4820 meq.

$NaOH_1$ used (= total $NaOH_1$ - excess $NaOH_1$) = $(25.0 \times 0.1009) - 2.4820$

= 0.0405 meq.

meq. of NaOH used to react with sample 1.0017 gm = 0.0405 meq.

---------- 1.0000 gm = 0.0404 meq. (M_1)

Sample 2 Weight of MGS = 1.0009 gm

Volume of $NaOH_2$ (for back titration) = 0.40 ml

meq. of NaOH used to react with sample 1.0000 gm = 0.0304 meq. (M_2)

Sample 3 Weight of MGS = 1.0016 gm

Volume of $NaOH_2$ (for back titration) = 0.45 ml

meq. of NaOH used to react with sample 1.0000 gm = 0.0353 meq. (M_3)

(using the same calculation method as described above)

Average meq. of NaOH used to react with sample 1.0000 gm = $(M_1+M_2+M_3)/3$

= 0.0354 (M)

- Calculation of degree of acid carboxymethyl substitution (A)

$$A = \frac{1150M}{7102 - 412M - 80C}$$

$$= \frac{1150(0.0354)}{7102 - 412(0.0354) - 80(11.74)} = 0.0066$$

- Calculation of sodium carboxymethyl substitution (S)

$$S = \frac{(162 + 58A)\,C}{7102 - 80C}$$

$$= \frac{(162 + 58(0.0066)) \times 11.74}{7102 - 80(11.74)} = 0.3093$$

- Calculation of degree of substitution (DS)

$$DS = A + S$$

$$= 0.0066 + 0.3093 = 0.3159$$

$$\approx 0.32$$

Appendix II

Particle Size Distribution Curves of Starting Materials

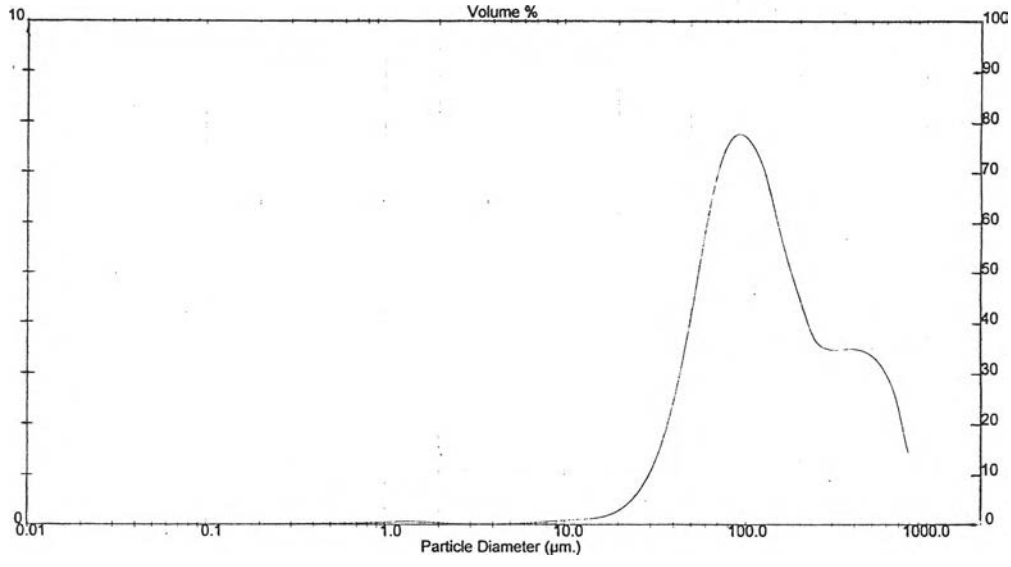


Figure 102 Particle size distribution curve of hydrous lactose.

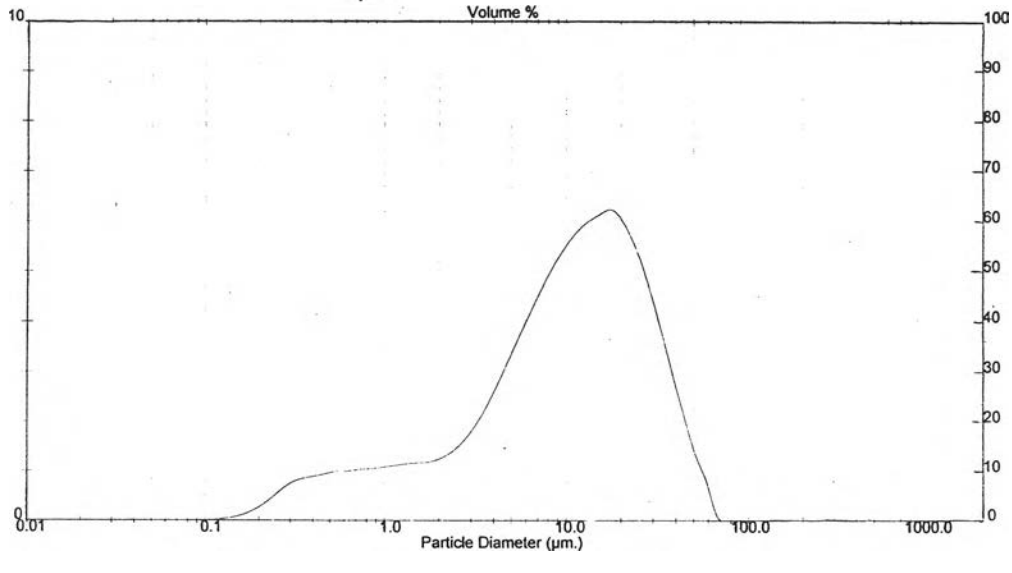


Figure 103 Particle size distribution curve of dicalcium phosphate dihydrate.

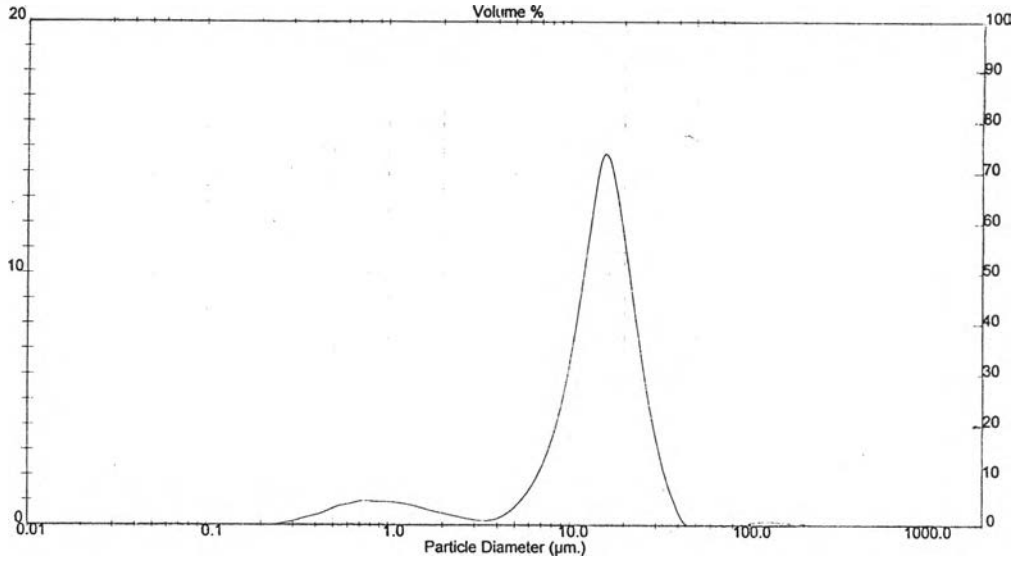


Figure 104 Particle size distribution curve of corn starch.

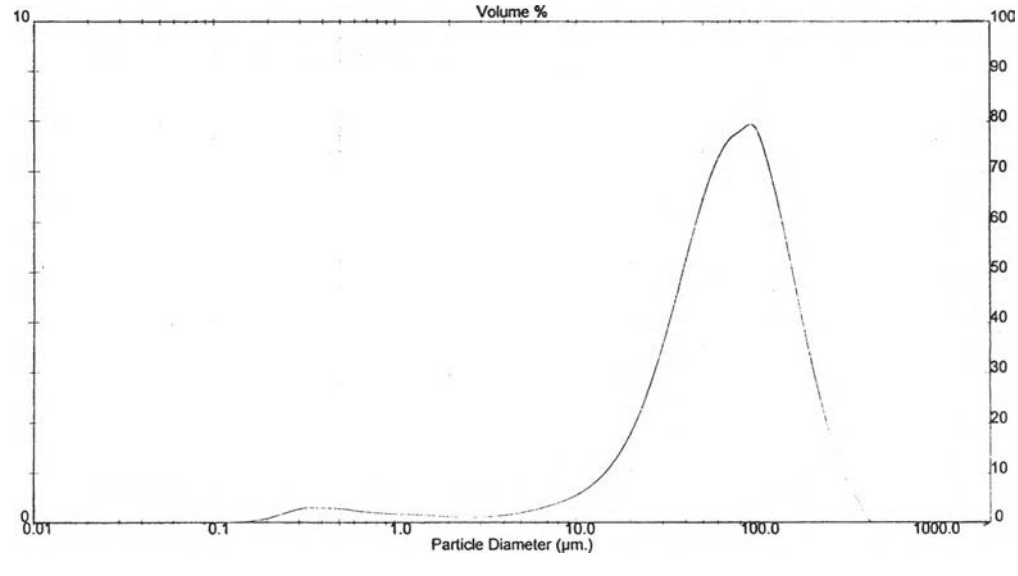


Figure 105 Particle size distribution curve of microcrystalline cellulose (Avicel® PH 101).

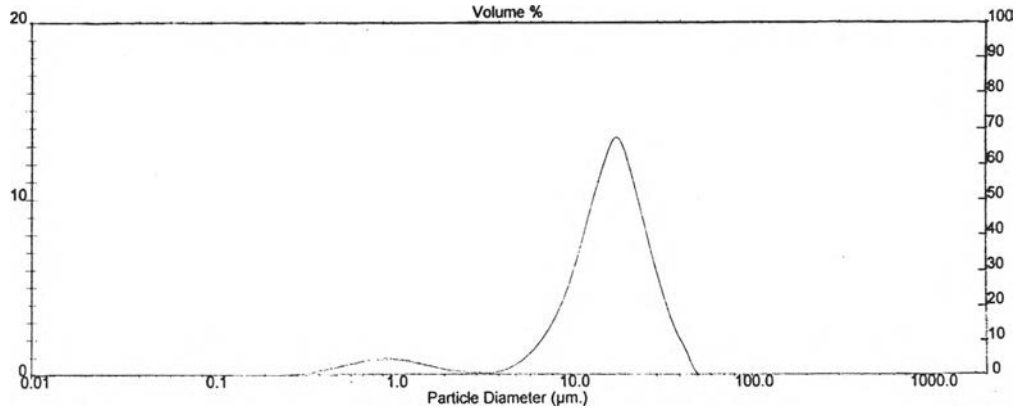


Figure 106 Particle size distribution of sucrose powder

Appendix III

Size Distribution Data and Percent Cumulative Undersize Plots

Table 36 Size distribution of 65 % lactose pellets prepared with different DS of MGS and amounts of water.

DS	MGS (%w/w)	Water (%)	Formulation	% Weight in each size range					
				< 250 *	250 - 500 *	500 - 710 *	710 - 1000 *	1000 - 1400*	> 1400*
0.32	0.5	38	$6L_{316}$	0.00	0.01	0.03	1.80	31.27	66.89
		37	$6L_{317}$	0.00	0.01	0.88	29.95	46.91	22.25
		36	$6L_{318}$	0.00	0.28	15.94	52.39	28.57	2.82
0.26	0.5	38	$6L_{21}$	0.00	0.00	0.01	1.85	30.62	67.52
		37	$6L_{22}$	0.00	0.01	0.48	27.70	50.56	21.24
		36	$6L_{23}$	0.00	0.12	4.93	49.32	44.00	1.64
0.16	0.5	38	$6L_{11}$	0.00	0.00	0.01	2.00	31.04	66.95
		37	$6L_{12}$	0.00	0.01	3.49	41.18	42.45	12.87
		36	$6L_{13}$	0.04	0.29	12.50	50.58	32.93	3.66
0**	-	38	B.1	0.00	0.00	2.93	45.48	41.24	10.36
		37	B.2	0.00	0.23	20.55	49.39	27.18	2.64
		36	B.3	0.00	1.42	26.40	47.79	22.97	1.42

* μm unit

** Blank pellets

Table 37 Size distribution of 80 % lactose pellets prepared with different DS of MGS and amounts of water.

DS	MGS (%w/w)	Water (%)	Formulation	% Weight in each size range					
				< 250 *	250 - 500 *	500 - 710 *	710 - 1000 *	1000 - 1400*	> 1400*
0.32	0.5	31	$8L_{32}$	0.00	0.00	0.03	10.66	51.10	38.21
		30	$8L_{33}$	0.00	0.00	0.09	17.68	54.62	27.61
		29	$8L_{34}$	0.00	0.19	18.39	62.99	18.15	0.29
0.26	0.5	31	$8L_{21}$	0.00	0.00	0.01	1.10	32.10	66.79
		30	$8L_{22}$	0.00	0.01	0.40	29.48	54.03	16.08
		29	$8L_{23}$	0.00	0.03	7.02	57.70	33.90	1.35
0.16	0.5	31	$8L_{11}$	0.00	0.00	0.88	35.60	50.75	12.77
		30	$8L_{12}$	0.00	0.01	5.31	53.26	38.67	2.75
		29	$8L_{13}$	0.00	0.85	21.23	62.44	15.22	0.27
0**	-	31	B.4	0.00	2.16	39.85	53.45	4.50	0.04
		30	B.5	0.01	5.42	46.50	44.90	3.14	0.03
		29	B.6	2.22	45.75	45.22	6.59	0.13	0.09

* μm unit

** Blank pellets

Table 38 Size distribution of 65 % dicalcium phosphate pellets prepared with different DS of MGS and amounts of water.

DS	MGS (%w/w)	Water (%)	Formulation	% Weight in each size range					
				< 250 *	250 - 500 *	500 - 710 *	710 - 1000 *	1000 - 1400*	> 1400*
0.32	0.5	52	$6D_{314}$	0.00	0.00	0.00	0.15	56.56	43.29
		50	$6D_{312}$	0.00	0.00	0.02	27.91	55.54	16.54
		48	$6D_{315}$	0.00	0.05	12.97	51.77	22.15	13.06
0.26	0.5	52	$6D_{21}$	0.00	0.00	0.01	0.81	66.09	33.09
		50	$6D_{22}$	0.00	0.01	0.13	34.47	49.62	15.77
		48	$6D_{23}$	0.00	0.20	27.05	44.96	20.87	6.93
0.16	0.5	52	$6D_{11}$	0.00	0.00	0.00	0.44	60.08	39.48
		50	$6D_{12}$	0.00	0.00	0.04	15.53	60.08	24.34
		48	$6D_{13}$	0.00	0.01	2.16	48.76	31.17	17.90
0**	-	52	B.7	0.00	0.00	0.03	0.41	88.43	11.13
		50	B.8	0.00	0.05	37.58	48.05	11.26	3.05
		48	B.9	0.00	3.83	59.38	23.71	9.72	3.36

* μm unit

** Blank pellets

Table 39 Size distribution of 80 % dicalcium phosphate pellets prepared with different DS of MGS and amounts of water.

DS	MGS (%w/w)	Water (%)	Formulation	% Weight in each size range					
				< 250 *	250 - 500 *	500 - 710 *	710 - 1000 *	1000 - 1400*	> 1400*
0.32	0.5	48	$8D_{32}$	0.00	0.00	0.01	0.27	71.42	28.30
		46	$8D_{34}$	0.00	0.00	0.01	22.74	71.35	5.90
		44	$8D_{35}$	0.00	0.01	0.10	51.84	40.09	7.96
0.26	0.5	48	$8D_{21}$	0.00	0.00	0.00	0.06	41.45	58.49
		46	$8D_{22}$	0.00	0.00	0.03	36.72	55.81	7.44
		44	$8D_{23}$	0.00	0.04	11.57	69.74	16.50	2.16
0.16	0.5	48	$8D_{11}$	0.00	0.00	0.01	11.72	77.68	10.59
		46	$8D_{12}$	0.00	0.00	0.06	29.75	62.45	7.73
		44	$8D_{13}$	0.00	0.01	9.66	72.35	16.48	1.50
0**	-	48	B.10	0.00	0.00	0.05	94.26	4.95	0.74
		46	B.11	0.00	0.01	43.19	53.92	2.34	0.54
		44	B.12	0.00	4.41	82.22	10.77	0.97	1.62

* μm unit

** Blank pellets

Table 40 Size distribution of lactose (65 %) pellets prepared with different amounts of MGS (DS 0.26) and 37 % of water.

MGS (%w/w)	Formulation	% Weight in each size range					
		<250 µm	250 - 500 µm	500 - 710 µm	710 - 1000 µm	1000 - 1400 µm	> 1400 µm
0.3	L.1	0.00	0.00	0.04	9.82	47.44	42.71
0.5	$6L_{22}$	0.00	0.01	0.48	27.70	50.56	21.24
0.8	L.2	0.00	0.00	0.00	3.40	41.20	55.41
0 *	B.2	0.00	0.23	20.55	49.39	27.18	2.64

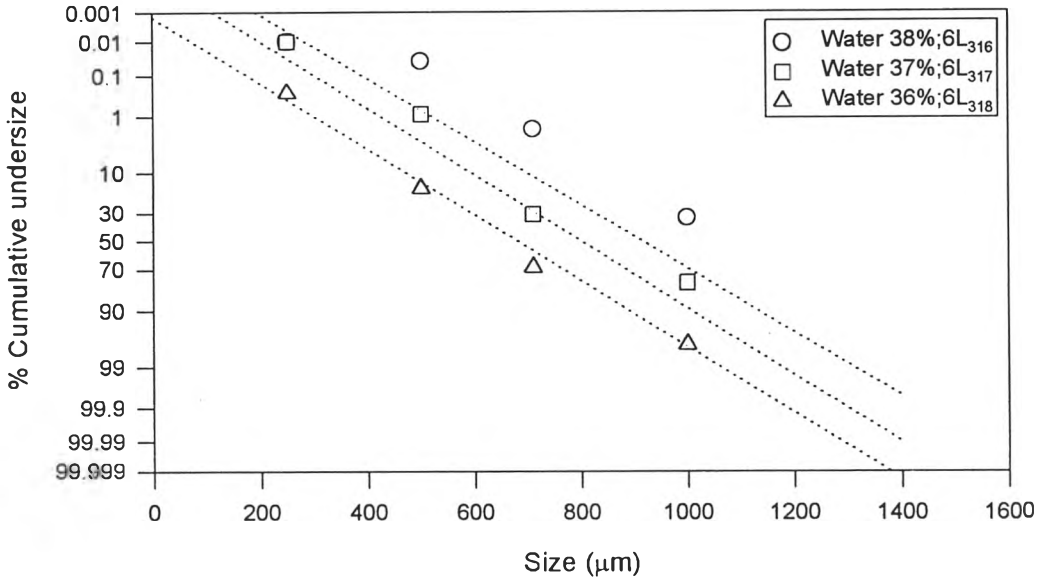
* Blank pellets

Table 41 Size distribution of dicalcium phosphate (80 %) pellets prepared with different amounts of MGS (DS 0.32) and 44 % of water.

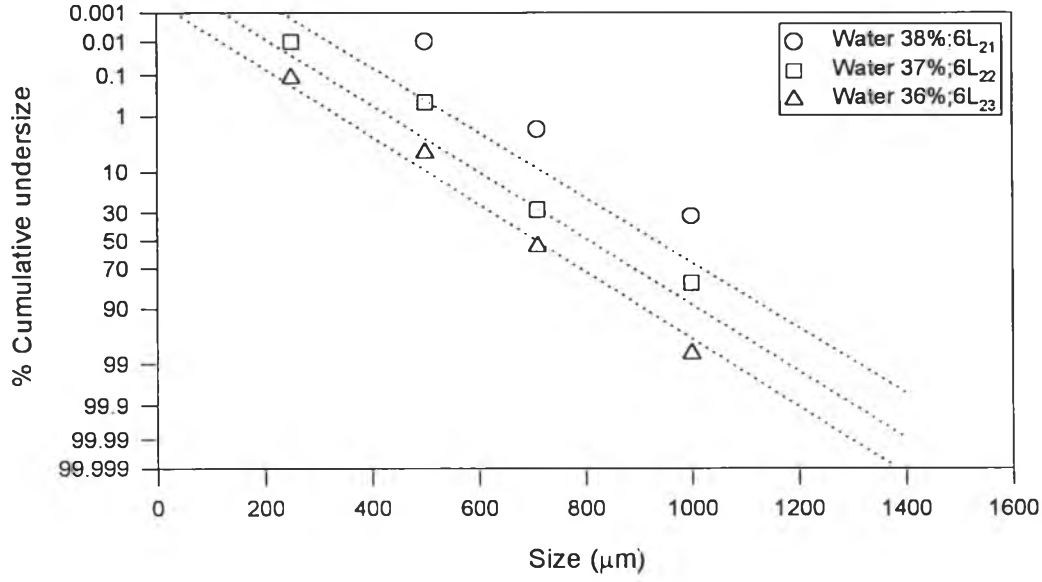
MGS (%w/w)	Formulation	% Weight in each size range					
		<250 μm	250 - 500 μm	500 - 710 μm	710 - 1000 μm	1000 - 1400 μm	> 1400 μm
0.3	D.1	0.00	0.10	55.97	37.63	5.55	0.75
0.5	$8LD_{35}$	0.00	0.01	0.10	51.84	40.09	7.96
0.8	D.2	0.00	0.00	4.75	63.36	26.76	5.12
0 *	B.12	0.00	4.41	82.22	10.77	0.97	1.62

* Blank pellets

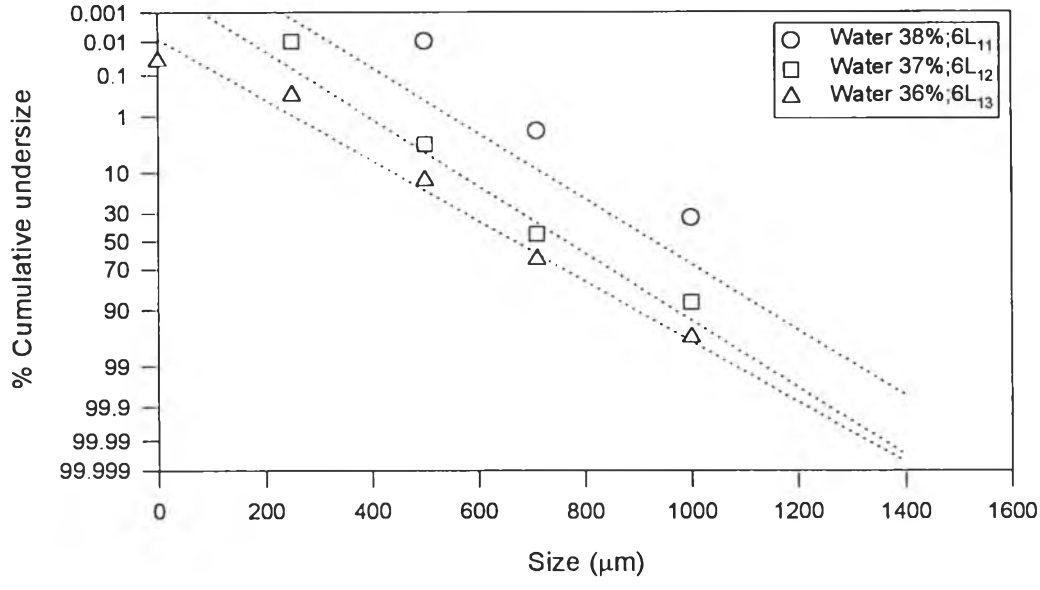
A.)


% Cumulative undersize
0.001
0.01
0.1
1
10
30
50
70
90
99
99.9
99.99
99.999
0
200
400
600
800
1000
1200
1400
1600
Size (μm)
Water 38%;6L316
Water 37%;6L317
Water 36%;6L318

B.)


% Cumulative undersize
0.001
0.01
0.1
1
10
30
50
70
90
99
99.9
99.99
99.999
0
200
400
600
800
1000
1200
1400
1600
Size (μm)
Water 38%;6L21
Water 37%;6L22
Water 36%;6L23

C.)



D.)

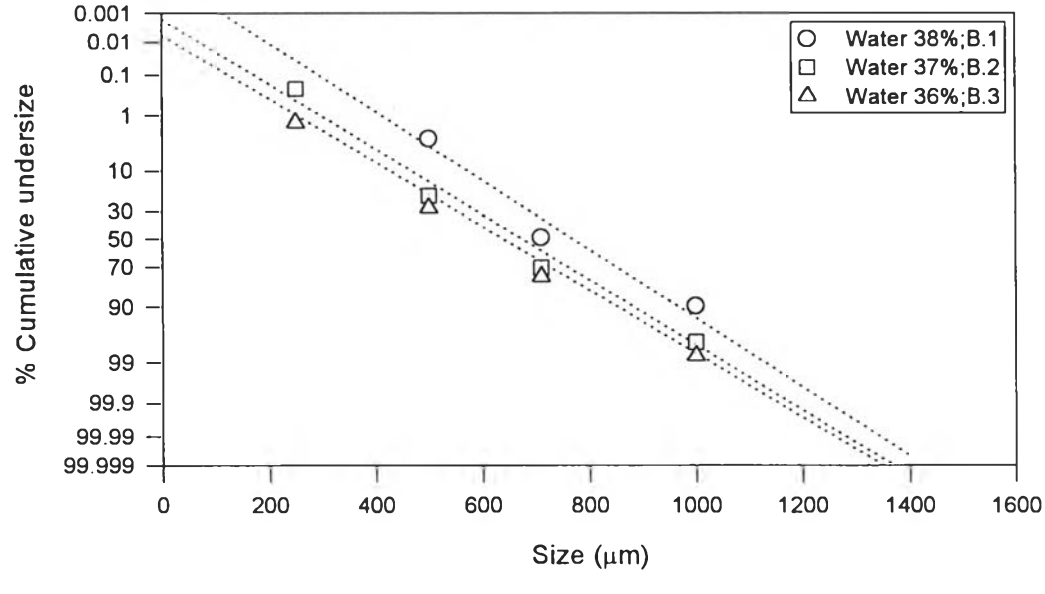
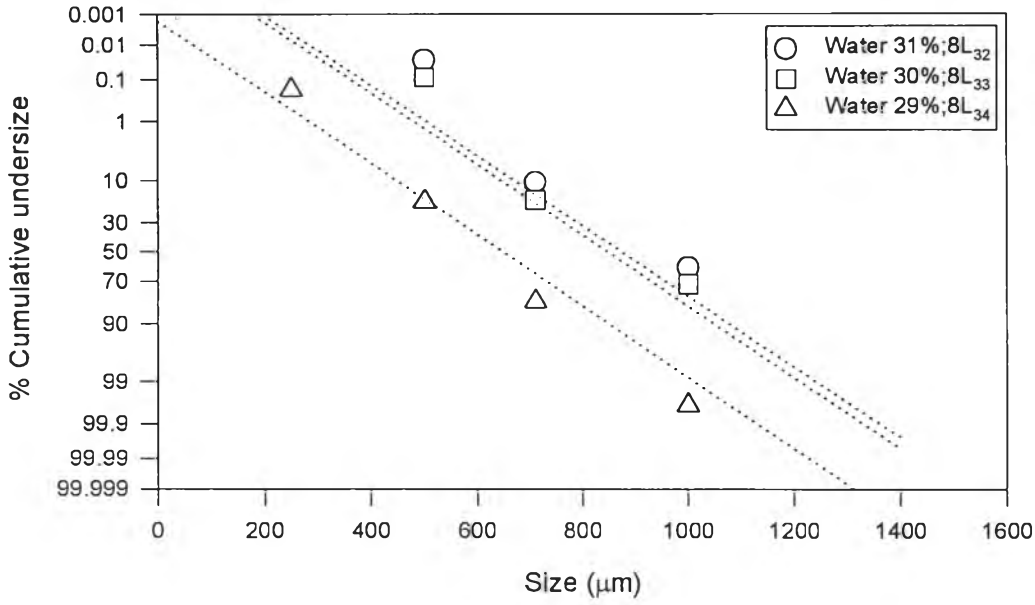
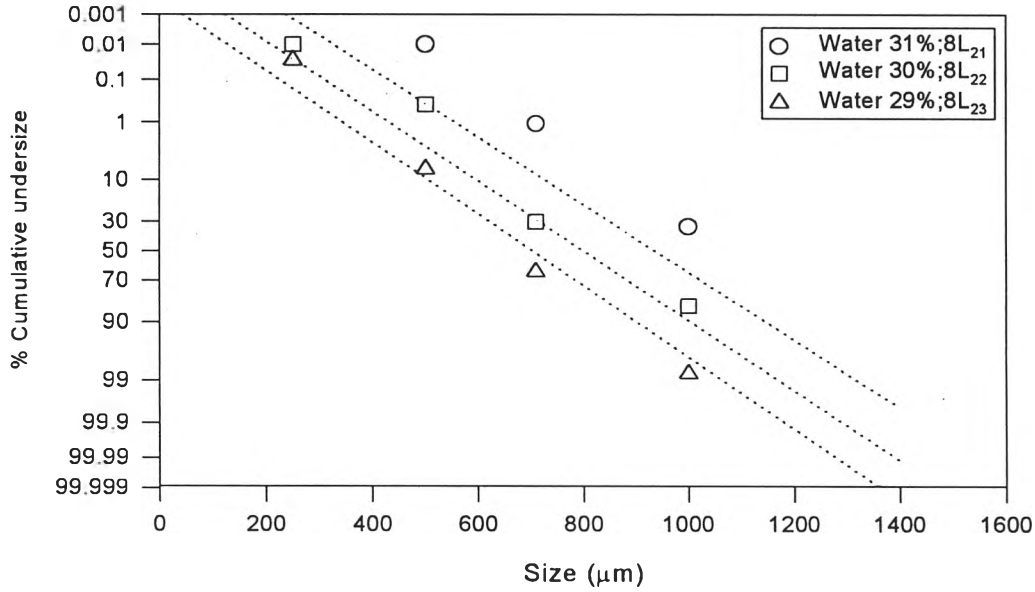


Figure 107 Percent cumulative undersize plots of 65% lactose pellets prepared with different DS of MGS [A) 0.32 ; B) 0.26 ; C) 0.16 and D) 0 (Blank pellets)] and amounts of water (%).

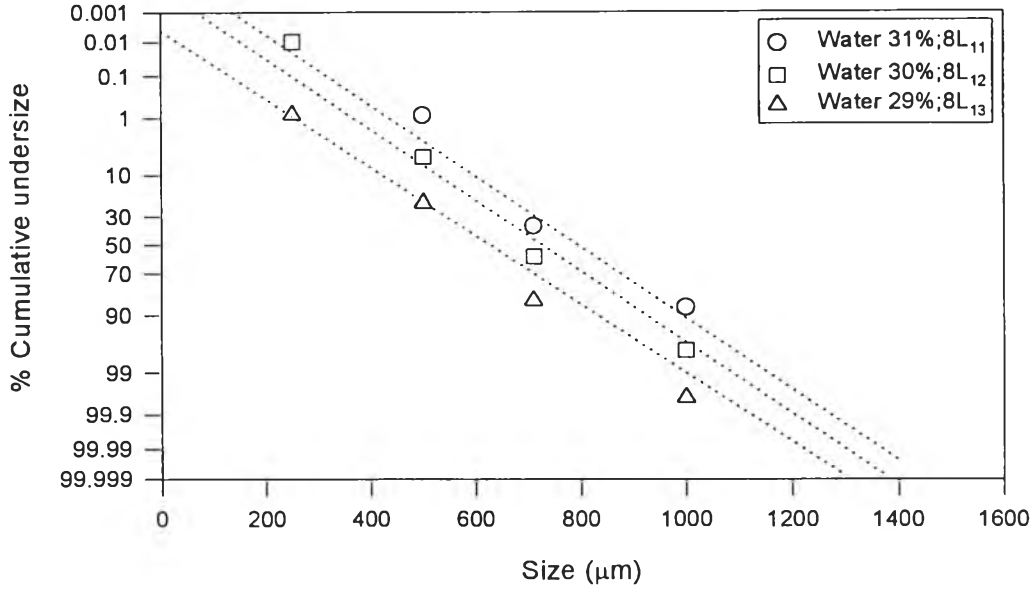
A.)


0.001
0.01
0.1
1
10
30
50
70
90
99
99.9
99.99
99.999
% Cumulative undersize
0
200
400
600
800
1000
1200
1400
1600
Size (μm)
Water 31%;8L32
Water 30%;8L33
Water 29%;8L34

B.)


0.001
0.01
0.1
1
10
30
50
70
90
99
99.9
99.99
99.999
% Cumulative undersize
0
200
400
600
800
1000
1200
1400
1600
Size (μm)
Water 31%;8L21
Water 30%;8L22
Water 29%;8L23

C.)



D.)

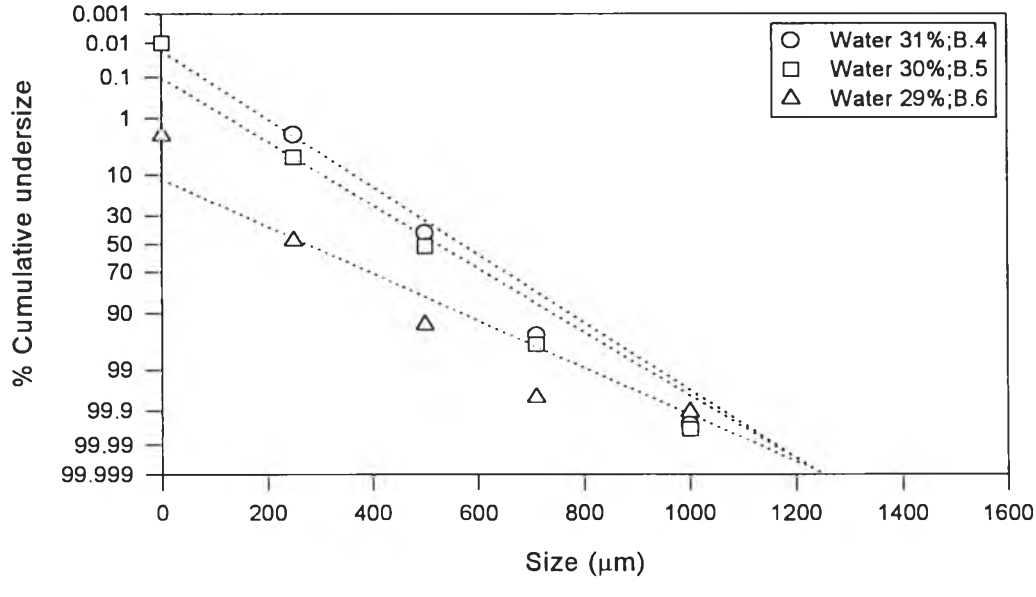
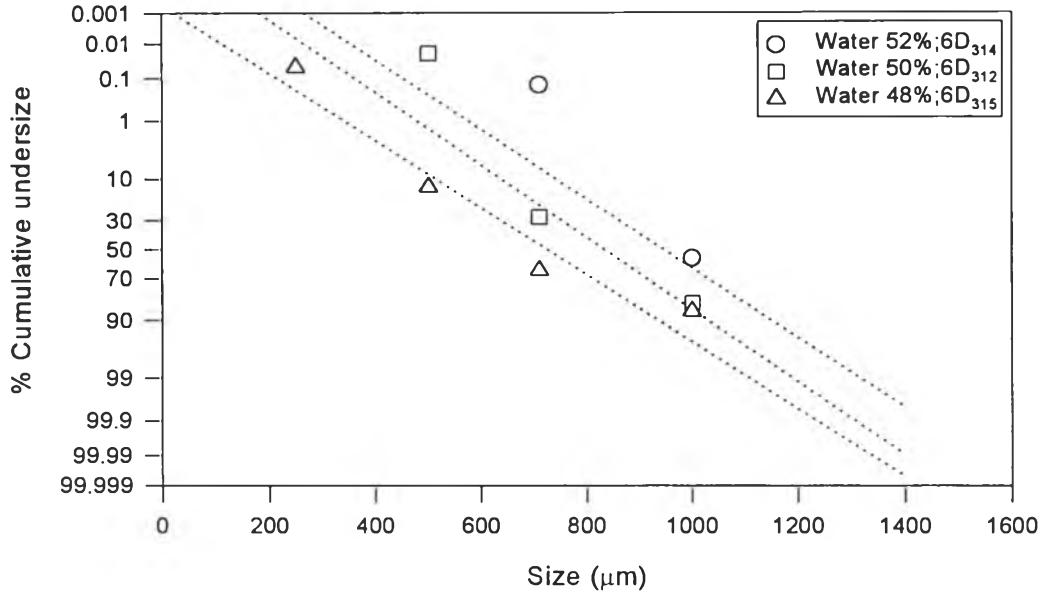
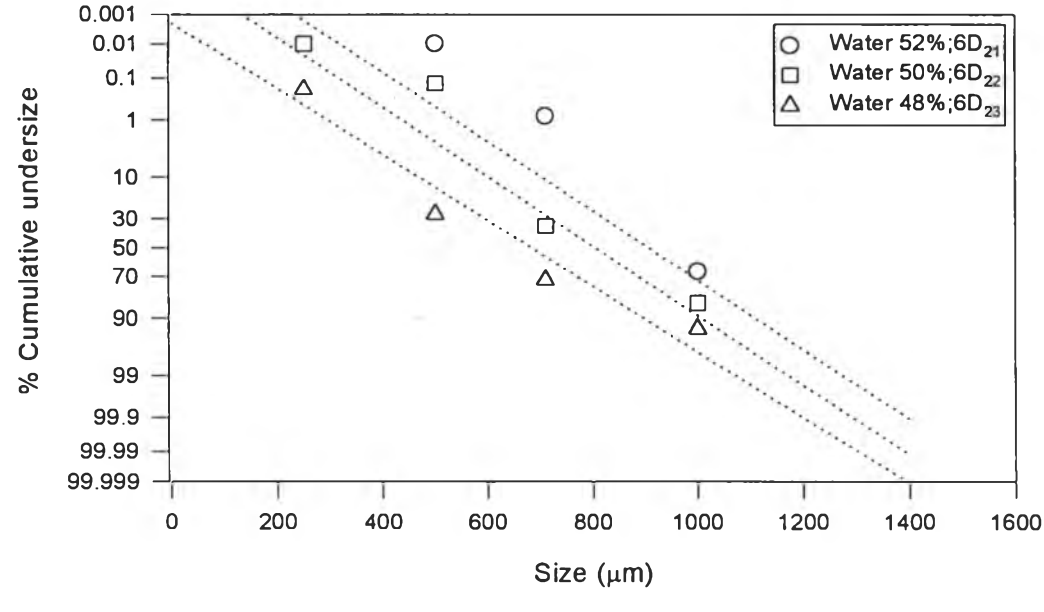


Figure 108 Percent cumulative undersize plots of 80% lactose pellets prepared with different DS of MGS [A) 0.32 ; B) 0.26 ; C) 0.16 and D) 0 (Blank pellets)] and amounts of water (%).

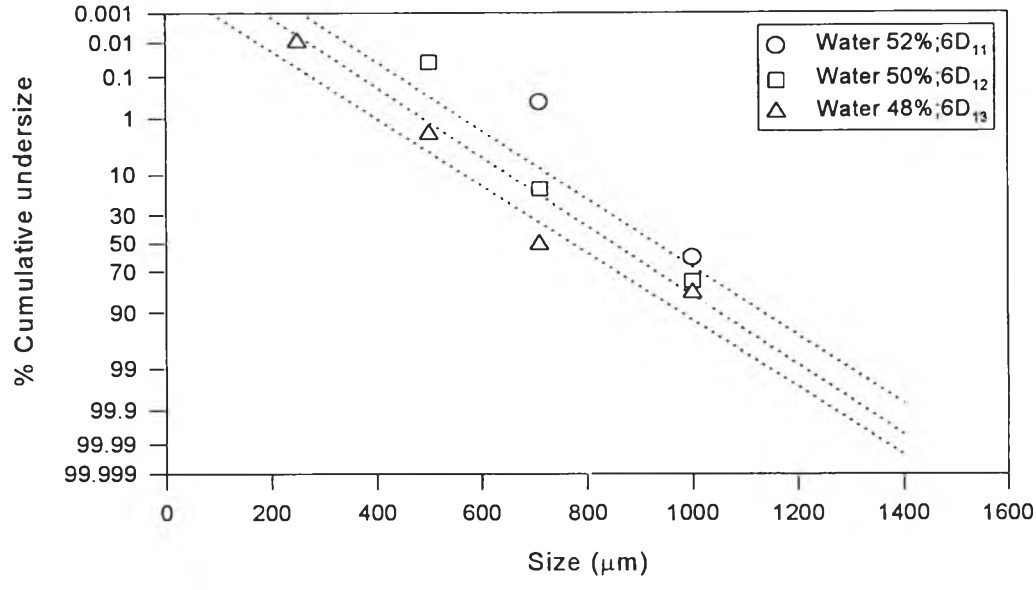
A.)


% Cumulative undersize
0.001
0.01
0.1
1
10
30
50
70
90
99
99.9
99.99
99.999
0
200
400
600
800
1000
1200
1400
1600
Size (μm)
Water 52%;6D314
Water 50%;6D312
Water 48%;6D315

B.)


% Cumulative undersize
0.001
0.01
0.1
1
10
30
50
70
90
99
99.9
99.99
99.999
0
200
400
600
800
1000
1200
1400
1600
Size (μm)
Water 52%;6D21
Water 50%;6D22
Water 48%;6D23

C.)



D.)

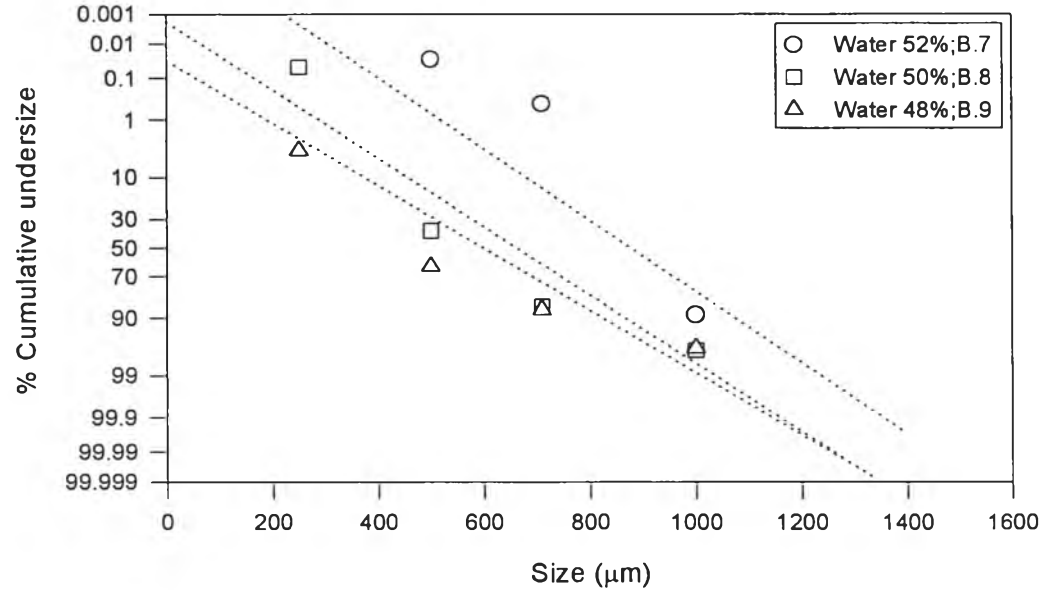
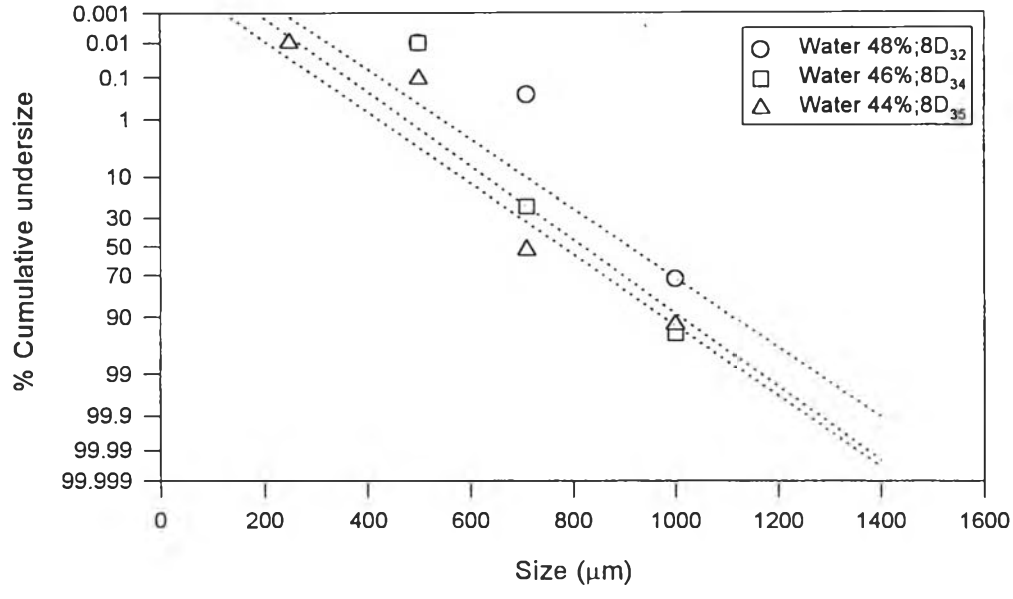
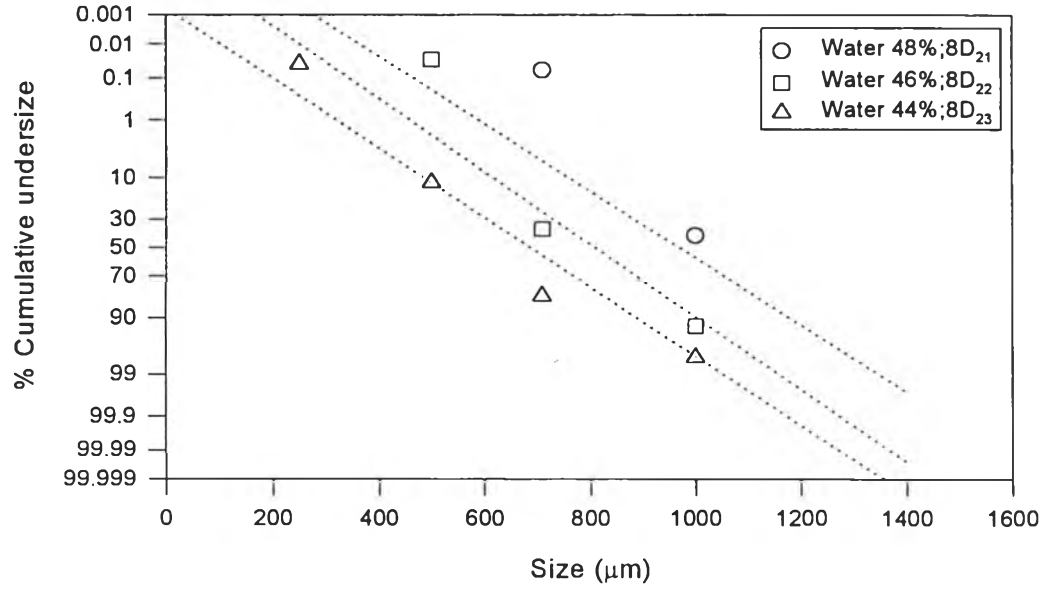


Figure 109 Percent cumulative undersize plots of 65% dicalcium phosphate pellets prepared with different DS of MGS [A) 0.32 ; B) 0.26 ; C) 0.16 and D) 0 (Blank pellets)] and amounts of water (%).

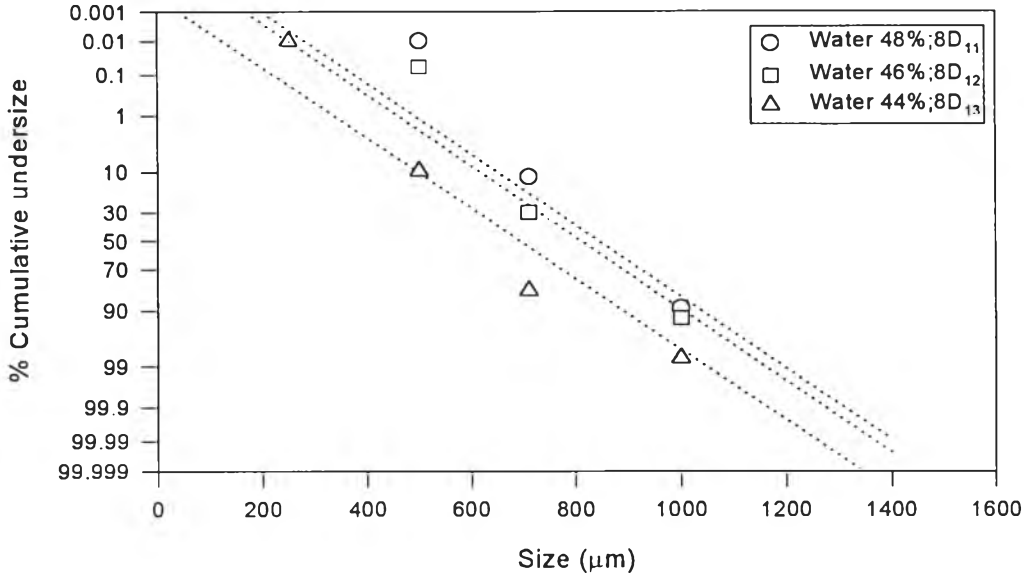
A.)


% Cumulative undersize
0.001
0.01
0.1
1
10
30
50
70
90
99
99.9
99.99
99.999
0
200
400
600
800
1000
1200
1400
1600
Size (μm)
Water 48%;8D32
Water 46%;8D34
Water 44%;8D35

B.)


% Cumulative undersize
0.001
0.01
0.1
1
10
30
50
70
90
99
99.9
99.99
99.999
0
200
400
600
800
1000
1200
1400
1600
Size (μm)
Water 48%;8D21
Water 46%;8D22
Water 44%;8D23

C.)



D.)

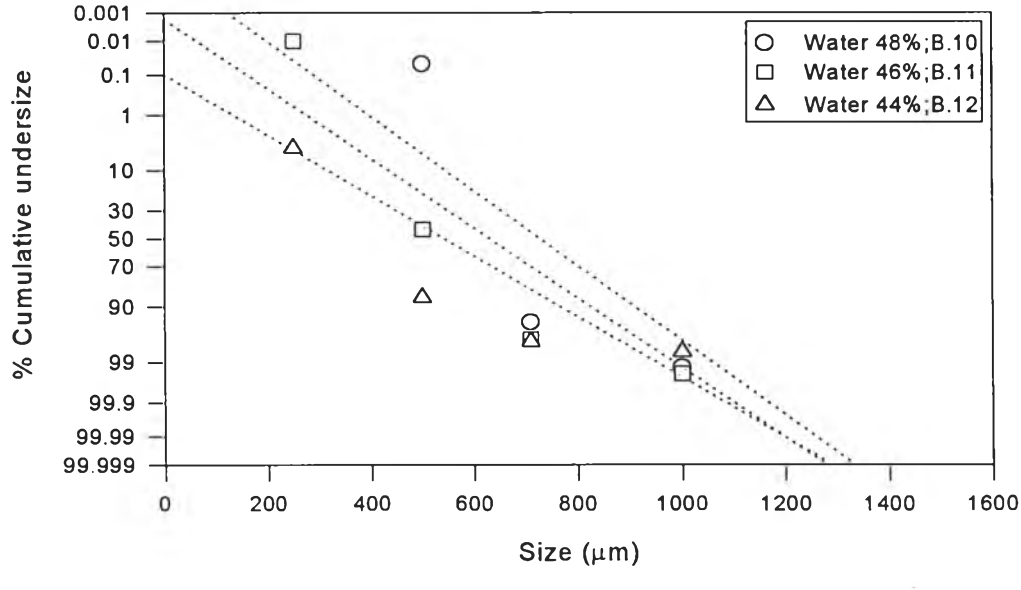


Figure 110 Percent cumulative undersize plots of 80% dicalcium phosphate pellets prepared with different DS of MGS [A) 0.32 ; B) 0.26 ; C) 0.16 and D) 0 (Blank pellets)] and amounts of water (%).

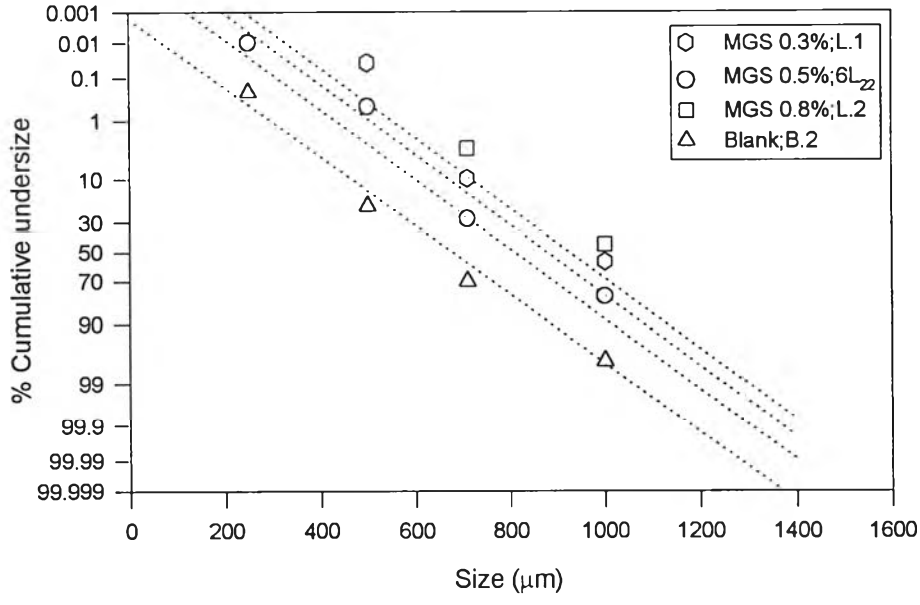


Figure 111 Percent cumulative undersize plots of lactose (65%) pellets prepared with different amounts of MGS (DS 0.26) and 37 % of water.

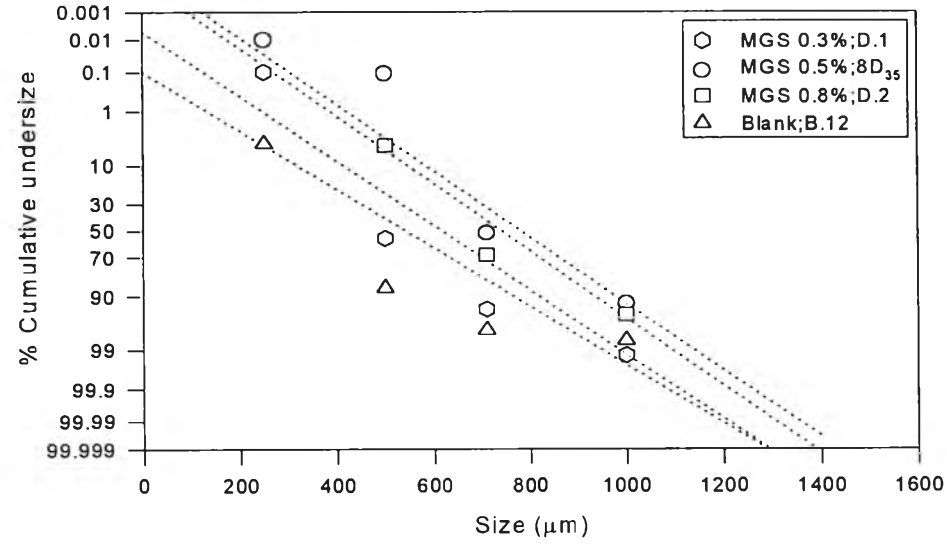


Figure 112 Percent cumulative undersize plots of dicalcium phosphate (80%) pellets prepared with different amounts of MGS (DS 0.32) and 44 % of water.

Appendix IV

Hardness and Friability Data

Table 42 Hardness at various size fractions of 65% lactose pellets prepared with different DS of MGS and amounts of water.

DS	MGS (% w/w)	Water (%)	Formulation	Hardness (N)		
				1000-1400*	710-1000 *	500-710 *
0.32	0.5	38	$6L_{316}$	7.179 (0.333**)	6.306 (0.532)	3.430 (0.454)
		37	$6L_{317}$	6.442 (0.486)	5.208 (0.284)	4.585 (0.369)
		36	$6L_{318}$	5.202 (0.490)	3.916 (0.334)	3.160 (0.283)
0.26	0.5	38	$6L_{21}$	7.310 (0.278)	6.510 (0.316)	-
		37	$6L_{22}$	5.864 (0.475)	5.345 (0.322)	4.713 (0.315)
		36	$6L_{23}$	5.496 (0.366)	4.666 (0.376)	3.999 (0.262)
0.16	0.5	38	$6L_{11}$	7.330 (0.315)	6.299 (0.393)	2.748 (0.266)
		37	$6L_{12}$	5.414 (0.464)	4.455 (0.223)	3.734 (0.398)
		36	$6L_{13}$	5.592 (0.449)	4.079 (0.421)	3.228 (0.180)
0 ***	-	38	B.1	6.100 (0.551)	4.120 (0.513)	3.394 (0.329)
		37	B.2	6.085 (0.466)	4.863 (0.646)	3.141 (0.284)
		36	B.3	4.611 (0.339)	3.153 (0.291)	2.155 (0.258)

Table 43 Hardness at various size fractions of 80 % lactose pelelts prepared with different DS of MGS and amounts of water.

DS	MGS (% w/w)	Water (%)	Formulation	Hardness (N)		
				1000-1400*	710-1000 *	500-710 *
0.32	0.5	31	$8L_{32}$	7.285 (0.276**)	5.699 (0.452)	4.281 (0.498)
		30	$8L_{33}$	6.267 (0.401)	5.584 (0.398)	4.362 (0.348)
		29	$8L_{34}$	5.294 (0.398)	4.221 (0.448)	3.636 (0.272)
0.26	0.5	31	$8L_{21}$	6.873 (0.574)	6.669 (0.253)	3.149 (0.167)
		30	$8L_{22}$	6.537 (0.379)	5.556 (0.549)	4.267 (0.239)
		29	$8L_{23}$	5.736 (0.635)	4.795 (0.324)	3.618 (0.395)
0.16	0.5	31	$8L_{11}$	6.224 (0.626)	5.217 (0.350)	3.873 (0.416)
		30	$8L_{12}$	5.515 (0.375)	4.503 (0.387)	3.820 (0.293)
		29	$8L_{13}$	5.403 (0.371)	3.995 (0.323)	3.414 (0.255)
0 ***	-	31	B.4	3.670 (0.694)	3.269 (0.372)	2.393 (0.277)
		30	B.5	3.456 (0.264)	2.649 (0.265)	2.238 (0.227)
		29	B.6	2.665 (0.401)	2.178 (0.187)	1.934 (0.180)

* Size (μm) ** Standard deviation *** Blank pellets

Table 44 Hardness at various size fractions of 65 % dicalcium phosphate pellets prepared with different DS of MGS and amounts of water.

DS	MGS (% w/w)	Water (%)	Formulation	Hardness (N)		
				1000-1400*	710-1000 *	500-710 *
0.32	0.5	52	$6D_{314}$	7.312 (0.821**)	6.545 (0.440)	-
		50	$6D_{312}$	5.925 (0.967)	6.430 (0.492)	3.786 (0.217)
		48	$6D_{315}$	5.143 (0.443)	5.084 (0.415)	3.531 (0.358)
0.26	0.5	52	$6D_{21}$	6.801 (1.409)	6.981 (0.427)	3.704 (0.323)
		50	$6D_{22}$	6.223 (0.919)	6.216 (0.314)	3.974 (0.319)
		48	$6D_{23}$	5.934 (0.584)	5.508 (0.389)	4.240 (0.256)
0.16	0.5	52	$6D_{11}$	6.401 (0.959)	6.741 (0.446)	-
		50	$6D_{12}$	7.312 (0.706)	6.528 (0.330)	3.475 (0.367)
		48	$6D_{13}$	6.556 (0.720)	6.231 (0.313)	4.002 (0.265)
0 ***	-	52	B.7	6.556 (0.735)	6.588 (0.438)	3.156 (0.309)
		50	B.8	5.290 (0.709)	4.870 (0.385)	3.261 (0.256)
		48	B.9	5.201 (0.778)	4.473 (0.418)	2.864 (0.272)

Table 45 Hardness at various size fractions of 80 % dicalcium phosphate pellets prepared with different DS of MGS and amounts of water.

DS	MGS (% w/w)	Water (%)	Formulation	Hardness (N)		
				1000-1400*	710-1000 *	500-710 *
0.32	0.5	48	$8D_{32}$	6.712 (0.685**)	6.786 (0.367)	3.445 (0.493)
		46	$8D_{34}$	5.756 (0.462)	6.321 (0.494)	2.736 (0.246)
		44	$8D_{35}$	5.979 (0.354)	5.961 (0.306)	3.520 (0.299)
0.26	0.5	48	$8D_{21}$	7.490 (0.611)	5.913 (0.310)	-
		46	$8D_{22}$	6.121 (0.631)	6.036 (0.292)	3.106 (0.385)
		44	$8D_{23}$	5.223 (0.595)	5.140 (0.469)	3.501 (0.153)
0.16	0.5	48	$8D_{11}$	6.156 (0.784)	6.280 (0.310)	3.595 (0.240)
		46	$8D_{12}$	6.823 (0.503)	5.560 (0.335)	3.250 (0.358)
		44	$8D_{13}$	5.490 (0.895)	5.238 (0.459)	3.430 (0.172)
0 ***	-	48	B.10	6.303 (0.497)	4.236 (0.451)	3.310 (0.186)
		46	B.11	5.211 (0.282)	3.333 (0.487)	2.819 (0.192)
		44	B.12	3.696 (0.322)	2.935 (0.284)	2.133 (0.167)

* Size (μm) ** Standard deviation *** Blank pellets

Table 46 Hardness at various size fractions of lactose (65%) pellets prepared with different amounts of MGS (DS 0.26) and 37 % of water.

MGS (% w/w)	Formulation	Hardness (N)		
		1000 -1400 μm	710 - 1000 μm	500 - 710 μm
0.3	L.1	6.036 (0.534*)	5.703 (0.559)	2.849 (0.294)
0.5	$6L_{21}$	5.864 (0.475)	5.345 (0.322)	4.713 (0.315)
0.8	L.2	6.843 (0.353)	6.475 (0.415)	3.104 (0.247)
0 **	B.2	6.085 (0.466)	4.863 (0.646)	3.141 (0.284)

* Standard deviation

** Blank pellets

Table 47 Hardness at various size fractions of lactose (80%) pellets prepared with different amounts of MGS (DS 0.32) and 44 % of water.

MGS (% w/w)	Formulation	Hardness (N)		
		1000 -1400 μm	710 - 1000 μm	500 - 710 μm
0.3	D.1	6.606 (0.400*)	4.525 (0.249)	3.063 (0.257)
0.5	$8D_{35}$	5.979 (0.354)	5.961 (0.306)	3.520 (0.299)
0.8	D.2	6.445 (0.502)	6.348 (0.477)	4.060 (0.252)
0 **	B.12	3.696 (0.322)	2.935 (0.284)	2.133 (0.167)

* Standard deviation

** Blank pellets

Table 48 Percent friability at various size fractions of 65 % lactose pelelts prepared with different DS of MGS and amounts of water.

DS	MGS (% w/w)	Water (%)	Formulation	Percent Friability		
				1000-1400*	710-1000 *	500-710 *
0.32	0.5	38	$6L_{316}$	0.78(0.26**)	1.44(0.06)	-
		37	$6L_{317}$	0.69(0.10)	0.95(0.06)	1.05(0.15)
		36	$6L_{318}$	1.31(0.06)	1.37(0.10)	1.47(0.10)
0.26	0.5	38	$6L_{21}$	1.01(0.06)	1.44(0.05)	-
		37	$6L_{22}$	0.72(0.06)	0.75(0.06)	-
		36	$6L_{23}$	0.95(0.06)	1.08(0.10)	1.21(0.05)
0.16	0.5	38	$6L_{11}$	0.72(0.25)	1.08(0.10)	-
		37	$6L_{12}$	0.65(0.15)	0.98(0.09)	1.24(0.06)
		36	$6L_{13}$	0.88(0.10)	1.31(0.14)	0.95(0.05)
0 ***	-	38	B.1	1.01(0.11)	0.03(0.06)	0.85(0.06)
		37	B.2	1.15(0.06)	0.82(0.25)	0.88(0.10)
		36	B.3	1.31(0.15)	0.46(0.15)	0.43(0.05)

Table 49 Percent friability at various size fractions of 80 % lactose pelelts prepared with different DS of MGS and amounts of water.

DS	MGS (% w/w)	Water (%)	Formulation	Percent Friability		
				1000-1400*	710-1000 *	500-710 *
0.32	0.5	31	$8L_{32}$	1.41(0.11**)	1.25(0.11)	-
		30	$8L_{33}$	1.21(0.06)	1.24(0.15)	-
		29	$8L_{34}$	1.21(0.06)	1.28(0.10)	1.31(0.15)
0.26	0.5	31	$8L_{21}$	1.41(0.06)	1.41(0.06)	-
		30	$8L_{22}$	1.34(0.15)	1.24(0.15)	-
		29	$8L_{23}$	1.31(0.15)	1.41(0.15)	1.28(0.10)
0.16	0.5	31	$8L_{11}$	1.28(0.10)	1.11(0.15)	1.02(0.05)
		30	$8L_{12}$	1.15(0.06)	1.15(0.11)	1.15(0.06)
		29	$8L_{13}$	1.18(0.10)	1.11(0.24)	1.08(0.10)
0 ***	-	31	B.4	1.38(0.10)	1.41(0.11)	1.44(0.06)
		30	B.5	1.74(0.28)	1.54(0.15)	1.47(0.10)
		29	B.6	-	2.52(0.05)	3.73(0.26)

* Size (μm) ** Standard deviation *** Blank pellets

Table 50 Percent friability at various size fractions of 65 % dicalcium phosphate pellets prepared with different DS of MGS and amounts of water.

DS	MGS (% w/w)	Water (%)	Formulation	Percent Friability		
				1000-1400*	710-1000 *	500-710 *
0.32	0.5	52	$6D_{314}$	1.18(0.10**)	-	-
		50	$6D_{312}$	0.98(0.10)	1.01(0.06)	-
		48	$6D_{315}$	1.37(0.00)	1.01(0.20)	1.18(0.17)
0.26	0.5	52	$6D_{21}$	0.85(0.11)	-	-
		50	$6D_{22}$	0.85(0.06)	0.72(0.11)	-
		48	$6D_{23}$	0.92(0.06)	0.75(0.06)	0.82(0.11)
0.16	0.5	52	$6D_{11}$	0.82(0.06)	0.82(0.20)	-
		50	$6D_{12}$	0.69(0.10)	0.82(0.15)	-
		48	$6D_{13}$	0.65(0.06)	0.75(0.05)	1.24(0.20)
0 ***	-	52	B.7	0.65(0.06)	-	-
		50	B.8	0.49(0.10)	0.29(0.10)	0.43(0.15)
		48	B.9	1.08(0.10)	0.72(0.06)	0.72(0.06)

Table 51 Percent friability at various size fractions of 80 % dicalcium phosphate pellets prepared with different DS of MGS and amounts of water.

DS	MGS (% w/w)	Water (%)	Formulation	Percent Friability		
				1000-1400*	710-1000 *	500-710 *
0.32	0.5	48	$8D_{32}$	1.41(0.06**)	-	-
		46	$8D_{34}$	1.31(0.06)	1.18(0.10)	-
		44	$8D_{35}$	1.41(0.11)	1.34(0.06)	-
0.26	0.5	48	$8D_{21}$	1.34(0.11)	-	-
		46	$8D_{22}$	1.37(0.10)	1.24(0.11)	-
		44	$8D_{23}$	1.31(0.15)	1.34(0.11)	1.44(0.06)
0.16	0.5	48	$8D_{11}$	1.18(0.20)	1.37(0.10)	-
		46	$8D_{12}$	1.34(0.06)	1.38(0.10)	-
		44	$8D_{13}$	1.44(0.06)	1.11(0.06)	1.37(0.10)
0 ***	-	48	B.10	1.37(0.10)	1.24(0.15)	-
		46	B.11	1.51(0.06)	1.14(0.06)	1.24(0.06)
		44	B.12	1.83(0.15)	1.47(0.00)	1.54(0.15)

* Size (μm) ** Standard deviation *** Blank pellets

Table 52 Percent friability at various size fraction of lactose (65%) pellets prepared with different amounts of MGS (DS 0.26) and 37% of water.

MGS (% w/w)	Formulation	Percent friability		
		1000 -1400 µm	710 - 1000 µm	500 - 710 µm
0.3	L.1	0.88 (0.20*)	0.49 (0.20)	-
0.5	$6L_{21}$	0.72 (0.06)	0.75 (0.06)	-
0.8	L.2	0.85 (0.06)	0.56 (0.15)	-
0 **	B.2	1.15 (0.06)	0.82 (0.25)	0.88 (0.10)

* Standard deviation

** Blank pellets

Table 53 Percent friability at various size fraction of dicalcium phosphate (80%) pellets prepared with different amounts of MGS (DS 0.32) and 44 % of water.

MGS (% w/w)	Formulation	Percent friability		
		1000 -1400 µm	710 - 1000 µm	500 - 710 µm
0.3	D.1	1.21 (0.06*)	0.95 (0.06)	1.01 (0.15)
0.5	$8D_{35}$	1.41 (0.11)	1.34 (0.06)	-
0.8	D.2	0.88 (0.00)	0.98 (0.00)	1.21 (0.06)
0 **	B.12	1.83 (0.15)	1.47 (0.00)	1.54 (0.15)

* Standard deviation

** Blank pellets

Appendix V

Data in Statistical Processes

Table 54 Analysis of variance for geometric mean diameter (D_{50}) 0f 65 % lactose pellets prepared with different DS of MGS and amounts of water.

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
D50	Main Effects	(Combined)	117291	5	23458.1	25.540	.001
		ds	25861.1	3	8620.38	9.385	.011
		WATER	91429.6	2	45714.8	49.772	.000
	Model		117291	5	23458.1	25.540	.001
	Residual		5510.92	6	918.487		
	Total		122802	11	11163.8		

a. D50 by ds, WATER

Table 55 Analysis of variance for geometric mean diameter (D_{50}) of 80 % lactose pellets prepared with different DS of MGS and amounts of water.

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
D50	Main Effects	(Combined)	353903	5	70780.6	39.873	.000
		ds	242341	3	80780.5	45.507	.000
		WATER	111562	2	55780.9	31.423	.001
	Model		353903	5	70780.6	39.873	.000
	Residual		10650.8	6	1775.14		
	Total		364554	11	33141.3		

a. D50 by ds, WATER

F ratio for 0.05 level of significance , if $df_1 = 3$ and $df_2 = 6$ is 4.76.

---------- , if $df_1 = 2$ and $df_2 = 6$ is 5.14.

Table 56 Analysis of variance for geometric mean diameter (D_{50}) of 65 % dicalcium phosphate pellets prepared with different DS of MGS and amounts of water.

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
D50	Main Effects	(Combined)	131631	5	26326.2	23.372	.001
		ds	34010.3	3	11336.8	10.065	.009
		WATER	97620.6	2	48810.3	43.333	.000
	Model		131631	5	26326.2	23.372	.001
	Residual		6758.35	6	1126.39		
	Total		138389	11	12580.8		

a. D50 by ds, WATER

Table 57 Analysis of variance for geometric mean diameter (D_{50}) of 80 % dicalcium phosphate pellets prepared with different DS of MGS and amounts of water.

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
D50	Main Effects	(Combined)	148406	5	29681.2	20.944	.001
		ds	78403.9	3	26134.6	18.442	.002
		WATER	70002.1	2	35001.0	24.698	.001
	Model		148406	5	29681.2	20.944	.001
	Residual		8502.93	6	1417.16		
	Total		156909	11	14264.4		

a. D50 by ds, WATER

F ratio for 0.05 level of significance , if $df_1 = 3$ and $df_2 = 6$ is 4.76.

---------- , if $df_1 = 2$ and $df_2 = 6$ is 5.14.

Table 58 Duncan's new multiple range tests for geometric mean diameter (D_{50}) of 65% lactose pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank(0)	0.16	0.26	0.32
Blank(0)	-	S	S	S
0.16		-	NS	NS
0.26			-	NS
0.32				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	60.54	62.64	63.69

B.)

H_2O(%v/w)	36	37	38
36	-	S	S
37		-	S
38			-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	52.43	52.25

S = significant difference

NS = non-significant difference

Table 59 Duncan's new multiple range tests for geometric mean diameter (D_{50}) of 80% lactose pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank(0)	0.16	0.26	0.32
Blank(0)	-	S	S	S
0.16		-	S	NS
0.26			-	NS
0.32				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	84.17	87.08	88.54

B.)

H_2O(%v/w)	29	30	31
29	-	S	S
30		-	NS
31			-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	72.89	75.42

S = significant difference

NS = non-significant difference

Table 60 Duncan's new multiple range tests for geometric mean diameter (D_{50}) of 65% dicalcium phosphate pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank(0)	0.16	0.26	0.32
Blank(0)	-	S	S	S
0.16		-	NS	NS
0.26			-	NS
0.32				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	67.04	69.37	70.53

B.)

H_2O(%v/w)	48	50	52
48	-	S	S
50		-	S
52			-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	58.06	60.08

S = significant difference

NS = non-significant difference

Table 61 Duncan's new multiple range tests for geometric mean diameter (D_{50}) of 80% dicalcium phosphate pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank(0)	0.16	0.26	0.32
Blank(0)	-	S	S	S
0.16		-	NS	NS
0.26			-	NS
0.32				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	75.20	77.81	79.11

B.)

H_2O(%v/w)	44	46	48
44	-	S	S
46		-	S
48			-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	65.13	67.39

S = significant difference

NS = non-significant difference

Table 62 Analysis of variance for bulk density of 65% lactose pellets prepared with different DS of MGS and amounts of water.

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
BULK	Main Effects	(Combined)	4.6E-03	5	9.2E-04	62.355	.000
		DS	4.1E-03	3	1.4E-03	93.124	.000
		WATER	4.8E-04	2	2.4E-04	16.202	.000
	2-Way Interactions	DS * WATER	2.4E-04	6	4.0E-05	2.743	.036
	Model		4.8E-03	11	4.4E-04	29.839	.000
	Residual		3.5E-04	24	1.5E-05		
	Total		5.2E-03	35	1.5E-04		

a. BULK by DS, WATER

Table 63 Analysis of variance for bulk density of 80% lactose pellets prepared with different DS of MGS and amounts of water.

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
BULK	Main Effects	(Combined)	9.1E-03	5	1.8E-03	103.452	.000
		DS	7.5E-03	3	2.5E-03	141.721	.000
		WATER	1.6E-03	2	8.1E-04	46.049	.000
	2-Way Interactions	DS * WATER	1.5E-03	6	2.5E-04	14.414	.000
	Model		1.1E-02	11	9.7E-04	54.886	.000
	Residual		4.2E-04	24	1.8E-05		
	Total		1.1E-02	35	3.2E-04		

a. BULK by DS, WATER

F ratio for 0.05 level of significance , if $df_1 = 3$ $df_2 = 24$ is 2.99.

---------- , if $df_1 = 2$ $df_2 = 24$ is 3.38.

---------- , if $df_1 = 6$ $df_2 = 24$ is 2.49.

Table 64 Analysis of variance for bulk density of 65% dicalcium phosphate pellets prepared with different DS of MGS and amounts of water.

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
BULK	Main Effects	(Combined)	1.5E-03	5	3.1E-04	12.479	.000
		DS	1.5E-03	3	4.9E-04	19.749	.000
		WATER	7.8E-05	2	3.9E-05	1.574	.228
	2-Way Interactions	DS * WATER	7.1E-04	6	1.2E-04	4.768	.002
	Model		2.3E-03	11	2.1E-04	8.273	.000
	Residual		6.0E-04	24	2.5E-05		
	Total		2.9E-03	35	8.2E-05		

a. BULK by DS, WATER

Table 65 Analysis of variance for bulk density of 80% dicalcium phosphate pellets prepared with different DS of MGS and amounts of water.

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
BULK	Main Effects	(Combined)	1.2E-03	5	2.4E-04	7.113	.000
		DS	8.3E-04	3	2.8E-04	8.183	.001
		WATER	3.7E-04	2	1.9E-04	5.507	.011
	2-Way Interactions	DS * WATER	4.5E-04	6	7.6E-05	2.235	.074
	Model		1.7E-03	11	1.5E-04	4.452	.001
	Residual		8.1E-04	24	3.4E-05		
	Total		2.5E-03	35	7.1E-05		

a. BULK by DS, WATER

F ratio for 0.05 level of significance , if $df_1 = 3$ $df_2 = 24$ is 2.99.

---------- , if $df_1 = 2$ $df_2 = 24$ is 3.38.

---------- , if $df_1 = 6$ $df_2 = 24$ is 2.49.

Table 66 Duncan's new multiple range tests for bulk density of 65% lactose pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank(0)	0.16	0.26	0.32
Blank(0)	-	S	S	S
0.16		-	S	S
0.26			-	S
0.32				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.00377	0.00396	0.00407

B.)

H_2O(%v/w)	36	37	38
36	-	S	S
37		-	S
38			-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.00327	0.00343

S = significant difference

NS = non-significant difference

Table 67 Duncan's new multiple range tests for bulk density of 80% lactose pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank(0)	0.16	0.26	0.32
Blank(0)	-	S	S	S
0.16		-	S	S
0.26			-	NS
0.32				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.00413	0.00434	0.00446

B.)

H_2O(%v/w)	29	30	31
29	-	NS	S
30		-	S
31			-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.00358	0.00376

S = significant difference

NS = non-significant difference

Table 68 Duncan's new multiple range tests for bulk density of 65% dicalcium phosphate pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank(0)	0.16	0.26	0.32
Blank(0)	-	S	S	S
0.16		-	S	S
0.26			-	NS
0.32				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.00487	0.00512	0.00525

B.)

H_2O(%v/w)	48	50	52
48	-	NS	NS
50		-	NS
52			-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.00422	0.00443

S = significant difference

NS = non-significant difference

Table 69 Duncan's new multiple range tests for bulk density of 80% dicalcium phosphate pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank(0)	0.16	0.26	0.32
Blank(0)	-	S	S	NS
0.16		-	NS	S
0.26			-	S
0.32				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.00568	0.00597	0.00612

B.)

H_2O(%v/w)	44	46	48
44	-	NS	S
46		-	NS
48			-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.00492	0.00517

S = significant difference

NS = non-significant difference

Table 70 Analysis of variance for bulk density of lactose (65%) pellets prepared with different amounts of MGS (DS 0.26) and 37 % of water.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Bulk density	Between Groups	1.7E-03	3	5.6E-04	17.895	.001
	Within Groups	2.5E-04	8	3.1E-05		
	Total	1.9E-03	11			

F ratio for 0.05 level of significance , if $df_1 = 3$ $df_2 = 8$ is 4.07.

Table 71 Duncan's new multiple range test for bulk density of lactose (65%) pellets prepared with different amounts of MGS (DS 0.26) and 37 % of water.

%MGS	0	0.3	0.5	0.8
0	-	S	S	S
0.3		-	S	NS
0.5			-	S
0.8				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.01048	0.001090	0.01115

S = significant difference

NS = non-significant difference

Table 72 Analysis of variance for bulk density of dicalcium phosphate (80%) pellets prepared with different amounts of MGS (DS 0.32) and 44 % of water.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Bulk density	Between Groups	2.1E-03	3	7.0E-04	65.612	.000
	Within Groups	8.5E-05	8	1.1E-05		
	Total	2.2E-03	11			

F ratio for 0.05 level of significance , if $df_1 = 3$ $df_2 = 8$ is 4.07.

Table 73 Duncan's new multiple range test for bulk density of dicalcium phosphate (80%) pellets prepared with different amounts of MGS (DS 0.32) and 44 % of water.

%MGS	0	0.3	0.5	0.8
0	-	S	NS	S
0.3		-	S	S
0.5			-	S
0.8				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.00729	0.00758	0.00776

S = significant difference

NS = non-significant difference

Table 74 Analysis of variance for tapped density of 65% lactose pellets prepared with different DS of MGS and amounts of water.

ANOVA [a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
TAPP	Main Effects	(Combined)	4.4E-03	5	8.9E-04	25.122	.000
		DS	2.9E-03	3	9.6E-04	27.113	.000
		WATER	1.6E-03	2	7.8E-04	22.136	.000
	2-Way Interactions	DS * WATER	1.4E-03	6	2.3E-04	6.445	.000
	Model		5.8E-03	11	5.3E-04	14.934	.000
	Residual		8.5E-04	24	3.5E-05		
	Total		6.7E-03	35	1.9E-04		

a. TAPP by DS, WATER

Table 75 Analysis of variance for tapped density of 80% lactose pellets prepared with different DS of MGS and amounts of water.

ANOVA [a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
TAPP	Main Effects	(Combined)	2.4E-03	5	4.8E-04	31.908	.000
		DS	2.1E-03	3	7.1E-04	47.796	.000
		WATER	2.4E-04	2	1.2E-04	8.076	.002
	2-Way Interactions	DS * WATER	9.9E-04	6	1.6E-04	11.074	.000
	Model		3.4E-03	11	3.1E-04	20.544	.000
	Residual		3.6E-04	24	1.5E-05		
	Total		3.7E-03	35	1.1E-04		

a. TAPP by DS, WATER

F ratio for 0.05 level of significance , if $df_1 = 3$ $df_2 = 24$ is 2.99.

---------- , if $df_1 = 2$ $df_2 = 24$ is 3.38.

---------- , if $df_1 = 6$ $df_2 = 24$ is 2.49.

Table 76 Analysis of variance for tapped density of 65% dicalcium phosphate pellets prepared with different DS of MGS and amounts of water.

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
TAPP	Main Effects	(Combined)	7.7E-03	5	1.5E-03	101.650	.000
		DS	3.7E-03	3	1.2E-03	81.572	.000
		WATER	4.0E-03	2	2.0E-03	131.766	.000
	2-Way Interactions	DS * WATER	1.4E-03	6	2.4E-04	15.674	.000
	Model		9.2E-03	11	8.3E-04	54.754	.000
	Residual		3.7E-04	24	1.5E-05		
	Total		9.5E-03	35	2.7E-04		

a. TAPP by DS, WATER

Table 77 Analysis of variance for tapped density of 80% dicalcium phosphate pellets prepared with different DS of MGS and amounts of water.

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
TAPP	Main Effects	(Combined)	7.5E-03	5	1.5E-03	17.866	.000
		DS	3.3E-03	3	1.1E-03	12.839	.000
		WATER	4.3E-03	2	2.1E-03	25.405	.000
	2-Way Interactions	DS * WATER	1.0E-03	6	1.7E-04	2.031	.101
	Model		8.6E-03	11	7.8E-04	9.229	.000
	Residual		2.0E-03	24	8.4E-05		
	Total		1.1E-02	35	3.0E-04		

a. TAPP by DS, WATER

F ratio for 0.05 level of significance , if $df_1 = 3$ $df_2 = 24$ is 2.99.

---------- , if $df_1 = 2$ $df_2 = 24$ is 3.38.

---------- , if $df_1 = 6$ $df_2 = 24$ is 2.49.

Table 78 Duncan's new multiple range tests for tapped density of 65% lactose pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank(0)	0.16	0.26	0.32
Blank(0)	-	S	S	S
0.16		-	S	S
0.26			-	S
0.32				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.00576	0.00605	0.00621

B.)

H_2O(%v/w)	36	37	38
36	-	S	NS
37		-	S
38			-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.00499	0.00524

S = significant difference

NS = non-significant difference

Table 79 Duncan's new multiple range tests for tapped density of 80% lactose pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank(0)	0.16	0.26	0.32
Blank(0)	-	S	S	S
0.16		-	S	S
0.26			-	NS
0.32				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.00377	0.00396	0.00407

B.)

H_2O(%v/w)	29	30	31
29	-	NS	S
30		-	S
31			-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.00327	0.00343

S = significant difference

NS = non-significant difference

Table 80 Duncan's new multiple range tests for tapped density of 65% dicalcium phosphate pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank(0)	0.16	0.26	0.32
Blank(0)	-	S	S	S
0.16		-	S	NS
0.26			-	S
0.32				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.00377	0.00396	0.00407

B.)

H_2O(%v/w)	48	50	52
48	-	S	S
50		-	S
52			-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.00327	0.00343

S = significant difference

NS = non-significant difference

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Table 82 Analysis of variance for tapped density of lactose (65%) lactose pellets prepared with different amounts of MGS (DS 0.26) and 37 % of water.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Tapped density	Between Groups	1.3E-03	3	4.2E-04	15.904	.001
	Within Groups	2.1E-04	8	2.7E-05		
	Total	1.5E-03	11			

F ratio for 0.05 level of significance , if $df_1 = 3$ $df_2 = 8$ is 4.07.

Table 83 Duncan's new multiple range test for tapped density of lactose (65%) pellets prepared with different amounts of MGS (DS 0.26) and 37 % of water.

%MGS	0	0.3	0.5	0.8
0	-	S	S	S
0.3		-	NS	NS
0.5			-	NS
0.8				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.00978	0.01017	0.01041

S = significant difference

NS = non-significant difference

Table 84 Analysis of variance for tapped density of dicalcium phosphate (80%) pellets prepared with different amounts of MGS (DS 0.32) and 44 % of water.

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Tapped density	Between Groups	2.0E-03	3	6.7E-04	32.889	.000
	Within Groups	1.6E-04	8	2.0E-05		
	Total	2.2E-03	11			

F ratio for 0.05 level of significance , if $df_1 = 3$ $df_2 = 8$ is 4.07.

Table 85 Duncan's new multiple range test for tapped density of dicalcium phosphate (80%) pellets prepared with different amounts of MGS (DS 0.32) and 44 % of water.

%MGS	0	0.3	0.5	0.8
0	-	S	NS	S
0.3		-	S	S
0.5			-	S
0.8				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.00842	0.00875	0.00896

S = significant difference

NS = non-significant difference

Table 86 Analysis of variance for hardness at various size fractions [A) 1000-1400 μm ; B) 710-1000 μm and C) 500-710 μm] of 65 % lactose pellets prepared with different DS of MGS and amounts of water.

A.)

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
Hardness:size 14-18	Main Effects	(Combined)	71.195	5	14.239	78.422	.000
		DS	8.713	3	2.904	15.996	.000
		WATER	62.481	2	31.241	172.060	.000
	2-Way Interactions	DS * WATER	13.216	6	2.203	12.132	.000
	Model		84.411	11	7.674	42.264	.000
	Residual		19.609	108	.182		
	Total		104.020	119	.874		

a. Hardness:size 14-18 by DS, WATER

B.)

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
Hardness:size 14-18	Main Effects	(Combined)	71.195	5	14.239	78.422	.000
		DS	8.713	3	2.904	15.996	.000
		WATER	62.481	2	31.241	172.060	.000
	2-Way Interactions	DS * WATER	13.216	6	2.203	12.132	.000
	Model		84.411	11	7.674	42.264	.000
	Residual		19.609	108	.182		
	Total		104.020	119	.874		

a. Hardness:size 14-18 by DS, WATER

F ratio for 0.05 level of significance , if $df_1 = 3$ $df_2 = 108$ is 2.60.

---------- , if $df_1 = 2$ $df_2 = 108$ is 2.99.

---------- , if $df_1 = 6$ $df_2 = 108$ is 2.09.

C.)

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
Hardness:size 25-35	Main Effects	(Combined)	46.015	5	9.203	91.485	.000
		DS	26.070	3	8.690	86.384	.000
		WATER	16.886	2	8.443	83.931	.000
	2-Way Interactions	DS * WATER	10.551	5	2.110	20.977	.000
	Model		56.566	10	5.657	56.231	.000
	Residual		9.959	99	.101		
	Total		66.525	109	.610		

a. Hardness:size 25-35 by DS, WATER

Table 87 Analysis of variance for hardness at various size fractions [A) 1000-1400 μm ; B) 710-1000 μm and C) 500-710 μm] of 80 % lactose pellets prepared with different DS of MGS and amounts of water.

A.)

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
Hardness:size 14-18	Main Effects	(Combined)	222.856	5	44.571	201.294	.000
		DS	192.109	3	64.036	289.203	.000
		WATER	30.747	2	15.374	69.431	.000
	2-Way Interactions	DS * WATER	5.475	6	.913	4.121	.001
	Model		228.331	11	20.757	93.745	.000
	Residual		23.914	108	.221		
	Total		252.245	119	2.120		

a. Hardness:size 14-18 by DS, WATER

F ratio for 0.05 level of significance , if $df_1 = 3$ $df_2 = 99$ or108 is 2.60.

---------- , if $df_1 = 2$ $df_2 = 99$ or108 is 2.99.

---------- , if $df_1 = 6$ $df_2 = 108$ is 2.09.

---------- , if $df_1 = 5$ $df_2 = 99$ is 2.21.

B.)

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
Hardness:size 18-25	Main Effects	(Combined)	192.352	5	38.470	279.126	.000
		DS	152.131	3	50.710	367.935	.000
		WATER	40.221	2	20.110	145.912	.000
	2-Way Interactions	DS * WATER	4.568	6	.761	5.524	.000
	Model		196.920	11	17.902	129.889	.000
	Residual		14.885	108	.138		
	Total		211.805	119	1.780		

a. Hardness:size 18-25 by DS, WATER

C.)

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
Hardness:size 25-35	Main Effects	(Combined)	68.949	5	13.790	141.658	.000
		DS	63.507	3	21.169	217.461	.000
		WATER	5.442	2	2.721	27.952	.000
	2-Way Interactions	DS * WATER	6.383	6	1.064	10.928	.000
	Model		75.332	11	6.848	70.350	.000
	Residual		10.513	108	9.7E-02		
	Total		85.845	119	.721		

a. Hardness:size 25-35 by DS, WATER

F ratio for 0.05 level of significance , if $df_1 = 3$ $df_2 = 108$ is 2.60.

---------- , if $df_1 = 2$ $df_2 = 108$ is 2.99.

---------- , if $df_1 = 6$ $df_2 = 108$ is 2.09.

Table 88 Analysis of variance for hardness at various size fractions [A) 1000-1400 μm ; B) 710-1000 μm and C) 500-710 μm] of 65 % dicalcium phosphate pellets prepared with different DS of MGS and amounts of water.

A.)

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
Hardness:size 14-18	Main Effects	(Combined)	40.368	5	8.074	12.616	.000
		DS	17.869	3	5.956	9.308	.000
		WATER	22.499	2	11.249	17.579	.000
	2-Way Interactions	DS * WATER	21.788	6	3.631	5.674	.000
	Model		62.155	11	5.650	8.830	.000
	Residual		69.115	108	.640		
	Total		131.270	119	1.103		

a. Hardness:size 14-18 by DS, WATER

B.)

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
Hardness:size 18-25	Main Effects	(Combined)	62.064	5	12.413	75.965	.000
		DS	23.424	3	7.808	47.785	.000
		WATER	38.639	2	19.320	118.236	.000
	2-Way Interactions	DS * WATER	12.005	6	2.001	12.245	.000
	Model		74.069	11	6.734	41.209	.000
	Residual		17.647	108	.163		
	Total		91.716	119	.771		

a. Hardness:size 18-25 by DS, WATER

F ratio for 0.05 level of significance , if $df_1 = 3$ $df_2 = 108$ is 2.60.

---------- , if $df_1 = 2$ $df_2 = 108$ is 2.99.

---------- , if $df_1 = 6$ $df_2 = 108$ is 2.09.

C.)

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
Hardness:size 25-35	Main Effects	(Combined)	12.650	5	2.530	28.526	.000
		DS	11.908	3	3.969	44.754	.000
		WATER	.344	2	.172	1.941	.150
	2-Way Interactions	DS * WATER	3.658	4	.914	10.311	.000
	Model		16.307	9	1.812	20.430	.000
	Residual		7.982	90	8.9E-02		
	Total		24.289	99	.245		

a. Hardness:size 25-35 by DS, WATER

Table 89 Analysis of variance for hardness at various size fractions [A) 1000-1400 μm ; B) 710-1000 μm and C) 500-710 μm] of 80 % dicalcium phosphate pellets prepared with different DS of MGS and amounts of water.

A.)

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
Hardness:size 14-18	Main Effects	(Combined)	78.200	5	15.640	46.497	.000
		DS	28.759	3	9.586	28.500	.000
		WATER	49.441	2	24.721	73.493	.000
	2-Way Interactions	DS * WATER	24.779	6	4.130	12.278	.000
	Model		102.979	11	9.362	27.832	.000
	Residual		36.327	108	.336		
	Total		139.307	119	1.171		

a. Hardness:size 14-18 by DS, WATER

F ratio for 0.05 level of significance , if $df_1 = 3$ $df_2 = 90$ or 108 is 2.60.

---------- , if $df_1 = 2$ $df_2 = 90$ or 108 is 2.99.

---------- , if $df_1 = 6$ $df_2 = 108$ is 2.09.

---------- , if $df_1 = 4$ $df_2 = 90$ is 2.37.

B.)

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
Hardness:size 18-25	Main Effects	(Combined)	159.278	5	31.856	210.726	.000
		DS	139.859	3	46.620	308.390	.000
		WATER	19.419	2	9.710	64.230	.000
	2-Way Interactions	DS * WATER	3.314	6	.552	3.653	.002
	Model		162.592	11	14.781	97.777	.000
	Residual		16.326	108	.151		
	Total		178.918	119	1.504		

a. Hardness:size 18-25 by DS, WATER

C.)

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
Hardness:size 25-35	Main Effects	(Combined)	12.587	5	2.517	31.493	.000
		DS	8.734	3	2.911	36.424	.000
		WATER	4.959	2	2.480	31.022	.000
	2-Way Interactions	DS * WATER	7.155	5	1.431	17.902	.000
	Model		19.741	10	1.974	24.697	.000
	Residual		7.913	99	8.0E-02		
	Total		27.655	109	.254		

a. Hardness:size 25-35 by DS, WATER

F ratio for 0.05 level of significance , if $df_1 = 3$ $df_2 = 99$ or 108 is 2.60.

---------- , if $df_1 = 2$ $df_2 = 99$ or 108 is 2.99.

---------- , if $df_1 = 6$ $df_2 = 108$ is 2.09.

---------- , if $df_1 = 5$ $df_2 = 99$ is 2.21.

Table 90 Duncan's new multiple range tests for hardness at 1000-1400 μm-size fraction of 65% lactose pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank (0)	0.16	0.26	0.32
Blank (0)	-	S	S	S
0.16		-	NS	NS
0.26			-	NS
0.32				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.216	0.227	0.235

B.)

H_2O(%v/w)	36	37	38
36	-	S	S
37		-	S
38			-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.187	0.197

S = significant difference

NS = non - significant difference

Table 91 Duncan's new multiple range tests for hardness at 710-1000 μm-size fraction of 65% lactose pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank (0)	0.16	0.26	0.32
Blank (0)	-	S	S	S
0.16		-	S	NS
0.26			-	S
0.32				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.205	0.216	0.223

B.)

H_2O(%v/w)	36	37	38
36	-	S	S
37		-	S
38			-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.177	0.187

S = significant difference

NS = non - significant difference

Table 92 Duncan's new multiple range tests for hardness at 500-710 μm-size fraction of 65% lactose pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank (0)	0.16	0.26	0.32
Blank (0)	-	S	S	S
0.16		-	S	S
0.26			-	S
0.32				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.162	0.171	0.177

B.)

H_2O(%v/w)	36	37	38
36	-	S	NS
37		-	S
38			-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.141	0.148

S = significant difference

NS = non - significant difference

Table 93 Duncan's new multiple range tests for hardness at 1000-1400 μm-size fraction of 80% lactose pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank (0)	0.16	0.26	0.32
Blank (0)	-	S	S	S
0.16		-	S	S
0.26			-	NS
0.32				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.238	0.251	0.259

B.)

H_2O(%v/w)	29	30	31
29	-	S	S
30		-	S
31			-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.206	0.217

S = significant difference

NS = non - significant difference

Table 94 Duncan's new multiple range tests for hardness at 710-1000 μm-size fraction of 80% lactose pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank (0)	0.16	0.26	0.32
Blank (0)	-	S	S	S
0.16		-	S	S
0.26			-	S
0.32				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.188	0.198	0.205

B.)

H_2O(%v/w)	29	30	31
29	-	S	S
30		-	S
31			-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.163	0.172

S = significant difference

NS = non - significant difference

Table 95 Duncan's new multiple range tests for hardness at 500-710 μm-size fraction of 80% lactose pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank (0)	0.16	0.26	0.32
Blank (0)	-	S	S	S
0.16		-	NS	S
0.26			-	S
0.32				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.158	0.166	0.172

B.)

H_2O(%v/w)	29	30	31
29	-	S	S
30		-	S
31			-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.136	0.144

S = significant difference

NS = non - significant difference

Table 96 Duncan's new multiple range tests for hardness at 1000-1400 μm-size fraction of 65% dicalcium phosphate pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank (0)	0.16	0.26	0.32
Blank (0)	-	S	S	S
0.16		-	S	S
0.26			-	NS
0.32				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.405	0.426	0.441

B.)

H_2O(%v/w)	48	50	52
48	-	S	S
50		-	S
52			-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.350	0.369

S = significant difference

NS = non - significant difference

Table 97 Duncan's new multiple range tests for hardness at 710-1000 μm-size fraction of 65% dicalcium phosphate pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank (0)	0.16	0.26	0.32
Blank (0)	-	S	S	S
0.16		-	S	S
0.26			-	S
0.32				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.204	0.215	0.223

B.)

H_2O(%v/w)	48	50	52
48	-	S	S
50		-	S
52			-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.177	0.186

S = significant difference

NS = non - significant difference

Table 98 Duncan's new multiple range tests for hardness at 500-710 μm-size fraction of 65% dicalcium phosphate pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank (0)	0.16	0.26	0.32
Blank (0)	-	S	S	S
0.16		-	S	NS
0.26			-	S
0.32				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.153	0.161	0.166

B.)

H_2O(%v/w)	48	50	52
48	-	NS	S
50		-	S
52			-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.132	0.139

S = significant difference

NS = non - significant difference

Table 99 Duncan's new multiple range tests for hardness at 1000-1400 μm-size fraction of 80% dicalcium phosphate pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank (0)	0.16	0.26	0.32
Blank (0)	-	S	S	S
0.16		-	NS	NS
0.26			-	NS
0.32				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.293	0.309	0.320

B.)

H_2O(%v/w)	44	46	48
44	-	S	S
46		-	S
48			-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.254	0.268

S = significant difference

NS = non - significant difference

Table 100 Duncan's new multiple range tests for hardness at 710-1000 μm-size fraction of 80% dicalcium phosphate pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank (0)	0.16	0.26	0.32
Blank (0)	-	S	S	S
0.16		-	NS	S
0.26			-	S
0.32				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.197	0.207	0.214

B.)

H_2O(%v/w)	44	46	48
44	-	S	S
46		-	S
48			-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.170	0.179

S = significant difference

NS = non - significant difference

Table 101 Duncan's new multiple range tests for hardness at 500-710 μm-size fraction of 80% dicalcium phosphate pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank (0)	0.16	0.26	0.32
Blank (0)	-	S	S	S
0.16		-	NS	S
0.26			-	NS
0.32				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.145	0.152	0.158

B.)

H_2O(%v/w)	44	46	48
44	-	S	S
46		-	S
48			-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.125	0.132

S = significant difference

NS = non - significant difference

Table 102 Analysis of variance for hardness at various size fractions [A) 1000-1400 μm ; B) 710-1000 μm and C) 500-710 μm] of lactose (65%) pellets prepared with different amounts of MGS (DS 0.26) and 37 % of water.

A.)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Hardness(size 14-18)	Between Groups	5.657	3	1.886	8.843	.000
	Within Groups	7.677	36	.213		
	Total	13.334	39			

B.)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Hardness(size 18-25)	Between Groups	13.853	3	4.618	18.359	.000
	Within Groups	9.055	36	.252		
	Total	22.908	39			

C.)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Hardness(size 25-35)	Between Groups	21.704	3	7.235	88.547	.000
	Within Groups	2.941	36	8.2E-02		
	Total	24.646	39			

F ratio for 0.05 level of significance , if $df_1=3$ $df_2=36$ is 2.69.

Table 103 Analysis of variance for hardness at various size fractions [A) 1000-1400 μm ; B) 710-1000 μm and C) 500-710 μm] of dicalcium phosphate (80%) pellets prepared with different amounts of MGS (DS 0.32) and 44 % of water.

A.)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Hardness(size 14-18)	Between Groups	54.682	3	18.227	113.616	.000
	Within Groups	5.775	36	.160		
	Total	60.457	39			

B.)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Hardness(size 18-25)	Between Groups	72.161	3	24.054	207.371	.000
	Within Groups	4.176	36	.116		
	Total	76.337	39			

C.)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Hardness(size 18-25)	Between Groups	72.161	3	24.054	207.371	.000
	Within Groups	4.176	36	.116		
	Total	76.337	39			

F ratio for 0.05 level of significance , if df_1=3 df_2=36 is 2.69.

Table 104 Duncan's new multiple range tests for hardness at various size fractions [A) 1000-1400 mm ; B) 710-1000 and C) 500-710 mm] of lactose (65%) pellets prepared with different amounts of MGS (DS 0.26) and 37 % of water.

A.)

%MGS	0	0.3	0.5	0.8
0	-	NS	NS	S
0.3		-	NS	S
0.5			-	S
0.8				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.417	0.439	0.452

B.)

%MGS	0	0.3	0.5	0.8
0	-	S	S	S
0.3		-	NS	S
0.5			-	S
0.8				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.454	0.478	0.492

S = significant difference

NS = non - significant difference

C.)

%MGS	0	0.3	0.5	0.8
0	-	S	S	NS
0.3		-	S	NS
0.5			-	S
0.8				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.259	0.273	0.281

Table 105 Duncan's new multiple range tests for hardness at various size fractions [A) 1000-1400 mm ; B) 710-1000 and C) 500-710 mm] of dicalcium phosphate (80%) pellets prepared with different amounts of MGS (DS 0.32) and 44% of water.

A.)

%MGS	0	0.3	0.5	0.8
0	-	S	NS	S
0.3		-	S	S
0.5			-	S
0.8				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.362	0.381	0.392

S = significant difference

NS = non - significant difference

B.)

%MGS	0	0.3	0.5	0.8
0	-	S	S	S
0.3		-	S	S
0.5			-	S
0.8				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.308	0.324	0.334

C.)

%MGS	0	0.3	0.5	0.8
0	-	S	S	S
0.3		-	S	S
0.5			-	S
0.8				-

The difference between two means is significant if mean(i) - mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.225	0.237	0.244

S = significant difference

NS = non - significant difference

Table 106 Analysis of variance for aspect ratio at various size fractions [A) 1000-1400 μm ; B) 710-1000 μm and C) 500-710 μm] of 65% lactose pellets prepared with different DS of MGS and amounts of water.

A.)

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
Aspect ratio(size 14-18)	Main Effects	(Combined)	.100	5	2.0E-02	9.121	.000
		DS	5.9E-02	3	2.0E-02	8.872	.000
		WATER	4.2E-02	2	2.1E-02	9.494	.000
	2-Way Interactions	DS * WATER	2.4E-02	6	4.1E-03	1.841	.092
	Model		.125	11	1.1E-02	5.150	.000
	Residual		.502	228	2.2E-03		
	Total		.627	239	2.6E-03		

a. Aspect ratio(size 14-18) by DS, WATER

B.)

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
Aspect ratio(size 18-25)	Main Effects	(Combined)	7.5E-02	5	1.5E-02	7.156	.000
		DS	6.7E-02	3	2.2E-02	10.661	.000
		WATER	7.9E-03	2	4.0E-03	1.897	.152
	2-Way Interactions	DS * WATER	1.0E-02	6	1.7E-03	.835	.544
	Model		8.5E-02	11	7.8E-03	3.708	.000
	Residual		.477	228	2.1E-03		
	Total		.562	239	2.4E-03		

a. Aspect ratio(size 18-25) by DS, WATER

F ratio for 0.05 level of significance , if df_1=3 df_2=228 is 2.60.

---------- , if df_1=2 df_2=228 is 2.99

---------- , if df_1=6 df_2=228 is 2.09.

C.)

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
Aspect ratio(size 25-35)	Main Effects	(Combined)	1.7E-02	5	3.5E-03	1.438	.211
		DS	4.0E-03	3	1.3E-03	.558	.644
		WATER	1.3E-02	2	6.7E-03	2.759	.065
	2-Way Interactions	DS * WATER	2.2E-02	6	3.7E-03	1.537	.167
	Model		4.0E-02	11	3.6E-03	1.492	.135
	Residual		.551	228	2.4E-03		
	Total		.591	239	2.5E-03		

a. Aspect ratio(size 25-35) by DS, WATER

Table 107 Analysis of variance for aspect ratio at various size fractions [A) 1000-1400 μm ; B) 710-1000 μm and C) 500-710 μm] of 80% lactose pellets prepared with different DS of MGS and amounts of water.

A.)

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
Aspect ratio(size 14-18)	Main Effects	(Combined)	.145	5	2.9E-02	11.375	.000
		DS	.112	3	3.7E-02	14.648	.000
		WATER	3.3E-02	2	1.6E-02	6.466	.002
	2-Way Interactions	DS * WATER	2.6E-02	6	4.3E-03	1.680	.127
	Model		.171	11	1.6E-02	6.087	.000
	Residual		.581	228	2.5E-03		
	Total		.752	239	3.1E-03		

a. Aspect ratio(size 14-18) by DS, WATER

F ratio for 0.05 level of significance , if df_1=3 df_2=228 is 2.60.

---------- , if df_1=2 df_2=228 is 2.99

---------- , if df_1=6 df_2=228 is 2.09.

B.)

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
Aspect ratio(size 18-25)	Main Effects	(Combined)	8.0E-02	5	1.6E-02	7.747	.000
		DS	7.9E-02	3	2.6E-02	12.686	.000
		WATER	1.4E-03	2	7.0E-04	.340	.712
	2-Way Interactions	DS * WATER	6.3E-03	6	1.0E-03	.504	.805
	Model		8.6E-02	11	7.9E-03	3.796	.000
	Residual		.472	228	2.1E-03		
	Total		.558	239	2.3E-03		

a. Aspect ratio(size 18-25) by DS, WATER

C.)

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
Aspect ratio(size 25-35)	Main Effects	(Combined)	3.1E-02	5	6.2E-03	1.843	.106
		DS	8.4E-03	3	2.8E-03	.833	.477
		WATER	2.3E-02	2	1.1E-02	3.357	.037
	2-Way Interactions	DS * WATER	4.0E-02	6	6.7E-03	1.990	.068
	Model		7.1E-02	11	6.5E-03	1.923	.038
	Residual		.768	228	3.4E-03		
	Total		.839	239	3.5E-03		

a. Aspect ratio(size 25-35) by DS, WATER

F ratio for 0.05 level of significance , if $df_1=3$ $df_2=228$ is 2.60.

---------- , if $df_1=2$ $df_2=228$ is 2.99

---------- , if $df_1=6$ $df_2=228$ is 2.09.

Table 108 Analysis of variance for aspect ratio at various size fractions [A) 1000-1400 μm ; B) 710-1000 μm and C) 500-710 μm] of 65% dicalcium phosphate pellets prepared with different DS of MGS and amounts of water.

A.)

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
Aspect ratio(size 14-18)	Main Effects	(Combined)	.226	5	4.5E-02	22.881	.000
		DS	.122	3	4.1E-02	20.654	.000
		WATER	.104	2	5.2E-02	26.220	.000
	2-Way Interactions	DS * WATER	6.2E-02	6	1.0E-02	5.218	.000
	Model		.288	11	2.6E-02	13.247	.000
	Residual		.451	228	2.0E-03		
	Total		.738	239	3.1E-03		

a. Aspect ratio(size 14-18) by DS, WATER

B.)

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
Aspect ratio(size 18-25)	Main Effects	(Combined)	4.4E-02	5	8.7E-03	5.978	.000
		DS	2.3E-02	3	7.6E-03	5.233	.002
		WATER	2.1E-02	2	1.0E-02	7.095	.001
	2-Way Interactions	DS * WATER	6.7E-02	6	1.1E-02	7.603	.000
	Model		.110	11	1.0E-02	6.864	.000
	Residual		.333	228	1.5E-03		
	Total		.443	239	1.9E-03		

a. Aspect ratio(size 18-25) by DS, WATER

F ratio for 0.05 level of significance , if df_1=3 df_2=228 is 2.60.

---------- , if df_1=2 df_2=228 is 2.99

---------- , if df_1=6 df_2=228 is 2.09.

C.)

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
Aspect ratio(size 25-35)	Main Effects	(Combined)	3.3E-02	5	6.7E-03	4.376	.001
		DS	2.0E-02	3	6.7E-03	4.380	.005
		WATER	1.3E-02	2	6.7E-03	4.351	.014
	2-Way Interactions	DS * WATER	1.3E-03	4	3.2E-04	.209	.933
	Model		3.5E-02	9	3.9E-03	2.524	.009
	Residual		.291	190	1.5E-03		
	Total		.326	199	1.6E-03		

a. Aspect ratio(size 25-35) by DS, WATER

Table 109 Analysis of variance for aspect ratio at various size fractions [A) 1000-1400 μm ; B) 710-1000 μm and C) 500-710 μm] of 80% dicalcium phosphate pellets prepared with different DS of MGS and amounts of water.

A.)

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
Aspect ratio(size 14-18)	Main Effects	(Combined)	.239	5	4.8E-02	21.345	.000
		DS	.165	3	5.5E-02	24.518	.000
		WATER	7.4E-02	2	3.7E-02	16.585	.000
	2-Way Interactions	DS * WATER	6.9E-02	6	1.2E-02	5.154	.000
	Model		.308	11	2.8E-02	12.513	.000
	Residual		.510	228	2.2E-03		
	Total		.818	239	3.4E-03		

a. Aspect ratio(size 14-18) by DS, WATER

F ratio for 0.05 level of significance , if df_1=3 df_2=190 or 228 is 2.60.

---------- , if df_1=2 df_2=190 or 228 is 2.99

---------- , if df_1=6 df_2=228 is 2.09.

---------- , if df_1=4 df_2=190 is 2.37.

B.)

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
Aspect ratio(size 18-25)	Main Effects	(Combined)	2.5E-02	5	5.0E-03	3.810	.002
		DS	1.3E-02	3	4.3E-03	3.303	.021
		WATER	1.2E-02	2	6.0E-03	4.571	.011
	2-Way Interactions	DS * WATER	8.5E-02	6	1.4E-02	10.820	.000
	Model		.110	11	1.0E-02	7.634	.000
	Residual		.297	228	1.3E-03		
	Total		.407	239	1.7E-03		

a. Aspect ratio(size 18-25) by DS, WATER

C.)

ANOVA[a]

			Experimental Method				
			Sum of Squares	df	Mean Square	F	Sig.
Aspect ratio(size 25-35)	Main Effects	(Combined)	1.6E-02	5	3.2E-03	1.712	.133
		DS	1.3E-02	3	4.4E-03	2.349	.074
		WATER	2.9E-03	2	1.4E-03	.773	.463
	2-Way Interactions	DS * WATER	3.6E-02	5	7.2E-03	3.886	.002
	Model		5.2E-02	10	5.2E-03	2.799	.003
	Residual		.387	209	1.9E-03		
	Total		.439	219	2.0E-03		

a. Aspect ratio(size 25-35) by DS, WATER

F ratio for 0.05 level of significance , if $df_1=3$ $df_2=209$ or 228 is 2.60.

---------- , if $df_1=2$ $df_2=209$ or 228 is 2.99

---------- , if $df_1=6$ $df_2=228$ is 2.09.

---------- , if $df_1=5$ $df_2=209$ is 2.21.

Table 110 Duncan's new multiple range tests for aspect ratio at 1000-1400 μm-size fraction of 65% lactose pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank (0)	0.16	0.26	0.32
Blank (0)	-	S	S	S
0.16		-	NS	NS
0.26			-	NS
0.32				-

The difference between two means is significant if means(i)-mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.0168	0.0177	0.0183

B.)

H_2O(%v/w)	36	37	38
36	-	NS	S
37		-	S
38			-

The difference between two means is significant if means(i)-mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.0145	0.0153

S = significant difference

NS = non - significant difference

Table 111 Duncan's new multiple range tests for aspect ratio at 710-1000 μm-size fraction of 65% lactose pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank (0)	0.16	0.26	0.32
Blank (0)	-	S	S	S
0.16		-	NS	NS
0.26			-	NS
0.32				-

The difference between two means is significant if means(i)-mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.0164	0.0173	0.0179

B.) Non - significant differences among different amounts of water.

Table 112 Duncan's new multiple range tests for aspect ratio at 1000-1400 μm-size fraction of 80% lactose pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank (0)	0.16	0.26	0.32
Blank (0)	-	S	S	S
0.16		-	NS	NS
0.26			-	NS
0.32				-

The difference between two means is significant if means(i)-mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.0179	0.0188	0.0195

B.)

H_2O(%v/w)	29	30	31
29	-	S	S
30		-	NS
31			-

The difference between two means is significant if means(i)-mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.0155	0.0163

S = significant difference

NS = non - significant difference

Table 113 Duncan's new multiple range tests for aspect ratio at 710-1000 μm-size fraction of 80% lactose pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank (0)	0.16	0.26	0.32
Blank (0)	-	S	S	S
0.16		-	NS	NS
0.26			-	NS
0.32				-

The difference between two means is significant if means(i)-mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.0164	0.0173	0.0179

B.) Non - significant differences among different amounts of water.

Table 114 Duncan's new multiple range tests for aspect ratio at 500-710 μm-size fraction of 80% lactose pellets compared between different DS of MGS (A) and different amounts of water (B).

A.) Non - significant differences among different DS of MGS.

B.)

H_2O(%v/w)	29	30	31
29	-	NS	S
30		-	NS
31			-

The difference between two means is significant if means(i)-mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.0181	0.0190

S = significant difference

NS = non - significant difference

Table 115 Duncan's new multiple range tests for aspect ratio at 1000-1400 μm-size fraction of 65% dicalcium phosphate pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank (0)	0.16	0.26	0.32
Blank (0)	-	S	S	S
0.16		-	NS	NS
0.26			-	NS
0.32				-

The difference between two means is significant if means(i)-mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.0160	0.0169	0.0174

B.)

H_2O(%v/w)	48	50	52
48	-	S	S
50		-	S
52			-

The difference between two means is significant if means(i)-mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.0139	0.0146

S = significant difference

NS = non - significant difference

Table 116 Duncan's new multiple range tests for aspect ratio at 710-1000 μm-size fraction of 65% dicalcium phosphate pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank (0)	0.16	0.26	0.32
Blank (0)	-	S	S	S
0.16		-	NS	NS
0.26			-	NS
0.32				-

The difference between two means is significant if means(i)-mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.0139	0.0146	0.0151

B.)

H_2O(%v/w)	48	50	52
48	-	S	NS
50		-	S
52			-

The difference between two means is significant if means(i)-mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.0120	0.0126

S = significant difference

NS = non - significant difference

Table 117 Duncan's new multiple range tests for aspect ratio at 500-710 μm-size fraction of 65% dicalcium phosphate pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank (0)	0.16	0.26	0.32
Blank (0)	-	S	NS	S
0.16		-	NS	NS
0.26			-	S
0.32				-

The difference between two means is significant if means(i)-mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.0139	0.0146	0.0151

B.)

H_2O(%v/w)	48	50	52
48	-	S	NS
50		-	S
52			-

The difference between two means is significant if means(i)-mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.0120	0.0126

S = significant difference

NS = non - significant difference

Table 118 Duncan's new multiple range tests for aspect ratio at 1000-1400 μm-size fraction of 80% dicalcium phosphate pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank (0)	0.16	0.26	0.32
Blank (0)	-	S	S	S
0.16		-	NS	NS
0.26			-	NS
0.32				-

The difference between two means is significant if means(i)-mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.0168	0.0177	0.0183

B.)

H_2O(%v/w)	44	46	48
44	-	S	S
46		-	S
48			-

The difference between two means is significant if means(i)-mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.0145	0.0153

S = significant difference

NS = non - significant difference

Table 119 Duncan's new multiple range tests for aspect ratio at 710-1000 μm-size fraction of 80% dicalcium phosphate pellets compared between different DS of MGS (A) and different amounts of water (B).

A.)

DS	Blank (0)	0.16	0.26	0.32
Blank (0)	-	S	NS	NS
0.16		-	S	S
0.26			-	NS
0.32				-

The difference between two means is significant if means(i)-mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.0129	0.0136	0.0141

B.)

H_2O(%v/w)	44	46	48
44	-	NS	S
46		-	NS
48			-

The difference between two means is significant if means(i)-mean(j) > LSR , based on the step of different means.

Step :	2	3
LSR :	0.0112	0.0118

S = significant difference

NS = non - significant difference

Table 120 Analysis of variance for aspect ratio at various size fractions [A) 1000-1400 μm ; B) 710-1000 μm and C) 500-710 μm] of lactose (65%) pellets prepared with different amounts of MGS (DS 0.26) and 37 % of water.

A.)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Aspect ratio(size 14-18)	Between Groups	5.7E-02	3	1.9E-02	6.859	.000
	Within Groups	.210	76	2.8E-03		
	Total	.267	79			

B.)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Aspect ratio(size 18-25)	Between Groups	1.9E-02	3	6.2E-03	3.292	.025
	Within Groups	.144	76	1.9E-03		
	Total	.163	79			

.C.)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Aspect ratio(size 25-35)	Between Groups	1.3E-03	3	4.2E-04	.265	.850
	Within Groups	.122	76	1.6E-03		
	Total	.123	79			

F ratio for 0.05 level of significance , if df_1=3 df_2=76 is 2.60.

Table 121 Analysis of variance for aspect ratio at various size fractions [A) 1000-1400 μm ; B) 710-1000 μm and C) 500-710 μm] of dicalcium phosphate (80%) pellets prepared with different amounts of MGS (DS 0.32) and 44 % of water.

A.)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Aspect ratio(size 14-18)	Between Groups	.128	3	4.3E-02	14.046	.000
	Within Groups	.230	76	3.0E-03		
	Total	.358	79			

B.)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Aspect ratio(size 18-25)	Between Groups	4.1E-02	3	1.4E-02	9.765	.000
	Within Groups	.106	76	1.4E-03		
	Total	.147	79			

C.)

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Aspect ratio(size 25-35)	Between Groups	3.5E-02	3	1.2E-02	3.865	.012
	Within Groups	.232	76	3.1E-03		
	Total	.267	79			

F ratio for 0.05 level of significance , if $df_1=3$ $df_2=76$ is 2.60.

Table 122 Duncan's new multiple range tests for aspect ratio at various size fractions [A) 1000-1400 μm ; B) 710-1000 μm and C)500-710 μm] of lactose (65%) pellets prepared with different amounts of MGS (DS 0.26) and 37 % of water.

A.)

%MGS	0	0.3	0.5	0.8
0	-	S	S	S
0.3		-	NS	NS
0.5			-	NS
0.8				-

The difference between two means is significant if means(i)-mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.0335	0.0353	0.0364

B.)

%MGS	0	0.3	0.5	0.8
0	-	S	S	S
0.3		-	NS	NS
0.5			-	NS
0.8				-

The difference between two means is significant if means(i)-mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.0267	0.0290	0.0300

C.) Non - significant difference among different amounts of MGS.

Table 123 Duncan's new multiple range tests for aspect ratio at various size fractions [A) 1000-1400 μm ; B) 710-1000 μm and C)500-710 μm] of dicalcium phosphate (80%) pellets prepared with different amounts of MGS (DS 0.32) and 44 % of water.

A.)

%MGS	0	0.3	0.5	0.8
0	-	S	S	S
0.3		-	S	S
0.5			-	NS
0.8				-

The difference between two means is significant if means(i)-mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.0347	0.0365	0.0377

B.)

%MGS	0	0.3	0.5	0.8
0	-	S	S	S
0.3		-	NS	NS
0.5			-	NS
0.8				-

The difference between two means is significant if means(i)-mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.0237	0.0249	0.0258

C.)

%MGS	0	0.3	0.5	0.8
0	-	S	S	S
0.3		-	NS	NS
0.5			-	NS
0.8				-

The difference between two means is significant if means(i)-mean(j) > LSR , based on the step of different means.

Step :	2	3	4
LSR :	0.0352	0.0371	0.0383

Vita

Miss Supattra Niyomthamakit was born on June 11 , 1970 in Bangkok. She was conferred her Bachelor degree of Pharmaceutical Science with second class honour in 1993 from Faculty of Pharmaceutical Science , Chulalongkorn University.