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Quick Determination of Water Phase Salt Content of Smoked Fish

OREGON STATE UNIVERSITY EXTENSION SERVICE

QUICK DETERMINATION OF WATER PHASE SALT CONTENT OF SMOKED FISH

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Achieving proper levels of salt and moisture in the production of smoked fish is a critical step in preservation. Salt analysis by official methods can be expensive and time consuming and requires skilled technicians. However, a good estimate of salt and moisture can be obtained using a much simpler (and less accurate) test which relies on "Chloride titrators" and a drying (or microwave) oven. This technique is accurate enough for quality control purposes, requires relatively inexpensive equipment, and is to easy learn. However, to be sure smoked products meet regulatory requirements, samples should be submitted to qualified laboratories as necessary.

The equipment and procedures listed below offer alternatives which generally trade accuracy for time, convenience, or expense. The most accurate procedure uses a drying oven for moisture analysis. The quickest procedure uses a microwave oven and special glass filter pads. A summary of equipment needed for the procedure requiring the least investment is shown on page 6 of this report.

EQUIPMENT & MATERIALS	APPROXIMATE COST (1990)
1. Chloride titrators (bottle of 50)	$26.50
Quantab no. 1176 (.05 to .6% range) Fisher Scientific or Environmental Test Systems (case lots only)	
or	
alternative electronic tester	$545.00
Presto-Tek SM-8 Salt Analyzer with 0 to 1.999% and 0 to 19.99% ranges	
2. Food blender with canning jar threaded screw on blades	
Osterizer 14 speed model 848-31 (lab model) VWR cat.no. 58977-033	57.00
or	
Discount houses (various household models)	30.00

3. Balance

BEST CHOICE - electronic

Sartorius Model 1002 (.1 g readability) 400.00
Fisher cat.no. 01-601-11
or
Ohaus Port-O-Gram model C501 470.00
Fisher cat.no. 01-919-65
VWR cat.no 11378091

NEXT BEST CHOICE - mechanical triple beam

Ohaus Model 760 (.1 readability) or similar) 110.00
Fisher cat.no. 02-034-20
VWR cat.no 12341-086

4. Small blending jars

BEST CHOICE - 1/2 pint Oster plastic blending jars 15.00
(6), available at discount stores
or
NEXT BEST CHOICE - 1 1/2 pint Oster plastic jars
Model 927-63 (6) 13.00
VWR cat.no. 58977-035
or
NEXT BEST CHOICE - 1/2 pint canning jars with standard screw threads to fit Oster blender blade assembly (6), (see safety caution in procedure) 12.00
Available at discount stores

5. Beakers, 250 ml Polypropylene - Griffin type (6) 13.00
VWR cat.no. 13890-080
Fisher cat.no. 02-591-10D
or
small used wide mouth food jars, 250 ml capacity 0.00

6. Graduate cylinder, 250 ml plastic 12.00
VWR cat.no. 24780-108
Fisher cat.no 08-572-5E

7. Water

BEST CHOICE - Distilled water (per gallon) 3.00
NEXT BEST CHOICE - clean tap water after checking for salt

8. Filter Paper

BEST CHOICE - 11 cm dia. coarse (per 500) 18.00
Fisher cat.no. 09-795d or VWR cat.no. 28310-081
or
NEXT BEST CHOICE - clean salt free paper towels 2.00

9. Drying oven

BEST CHOICE - 1/2 degree centigrade control 685.00
VWR brand model OV-8A, VWR cat.no. 52348-310
or
NEXT BEST CHOICE - 5 degree plus or minus control
Isotemp 500 series model 5066 330.00
Fisher cat.no. 13-245-5066
or
ACCEPTABLE CHOICE - any electric oven capable of maintaining about 100 C (212 F) without smoking sample (about 110 C)
or
when using ALTERNATIVE MICROWAVE PROCEDURE
carosel microwave cabable of 1 sec timing interval 350.00

Glass fiber sample pads - per box 400 (1 to 5 boxes) 34.00
C.E.M Corp

small microwavable paper plates 2.00
local grocery store (per 100)

10. Wash bottle, 250 ml polyethylene

Fisher cat.no. 03-409-10D	(4 ea.)	8.00
VWR cat.no. 16651-165	(6 ea.)	12.60
some local drug stores may carry these	(1)	3.00

EQUIPMENT SOURCES

The following companies are among many who supply equally good equipment at comparable prices. The use of names here is for example only and does not imply any endorsement.

Environmental Test Systems
PO Box 4659
Elkhart, Ind 46514
219 262-2060

C.E.M. Corp
PO Box 200
Matthews, NC 28106
800 334-6317

VWR Scientific
PO Box 3551
Seattle, WA 98124
206 575-1500

Fisher Scientific
8030 S. 228th St
PO Box 1148
Kent, WA 98032
206 872-0330

Presto-Tek
4101 N. Figueroa St.
LosAngeles, CA 90065
1-800-421 8660

PROCEDURE

A. SAMPLE PREPARATION

1. Cut 150 to 200 gram sample (about 1 x 1 x 3 inches) from thickest section of largest piece of fish from batch. Remove skin and blend until well chopped and mixed. CAUTION - if using glass canning jars, do not operate blender while holding the jar. Severe injury can result if the jar breaks.

2. Place lid on blended sample and retain in refrigerator until satisfactory completion of salt and moisture analysis.

B. I. MOISTURE ANALYSIS (using drying oven)

1. Prepare 3 x 3 inch "weighing" boat (tray) from aluminum foil by folding it to create about 1/4 inch sides.

2. Weigh and record weight of aluminum boat.

3. Add about 10 grams of ground sample and record total weight.

4. Place sample in 100 degree centigrade (212 °F) oven and dry over night to constant weight. This will take 10 to 15 hours depending on sample texture and size. Weigh the tray and sample several times (record time and weight) over a 2 to 3 hour period to make sure sample has dried to constant weight.

5. Compute percent moisture as weight lost divided by sample weight multiplied by 100.

$$\% \text{ moisture} = \frac{\text{weight loss}}{\text{sample weight}} \times 100$$

B. II. MOISTURE ANALYSIS (using microwave oven and glass fiber pads)

1. Dry two CEM glass fiber sample pads and two microwave safe paper plates to constant weight in microwave oven (about 1 minute)

2. Zero the balance. Place one predried glass pad on the balance (use forceps). Place one paper plate containing the second glass pad on top of the first pad. Weigh and record weight.

3. Weigh and record weight of about 10 grams (± .1 g) ground sample on the glass fiber pad which is nested in the paper plate. Spread sample, and cover with second pad and a second paper plate (inverted). Mark the top plate because it will not be weighed.

4. Remove sample, pads, and plates from balance then compress sample by pressing firmly on top plate (do not contaminate the sample with grease from fingers or other foreign matter).

5. Microwave for 30 seconds, lift top plate and pad using forceps, and blot moisture from the lower plate with paper towel.

6. Replace top plate and pads. Microwave for another 60 seconds. Record weight.

7. Invert the two pads on the lower plate, replace upper plate and microwave for additional 30 seconds. Record weight. Repeat step 7 if necessary until no further weight loss is observed. Do not "smoke" sample.

8. Record weight, compute weight loss, and calculate percent moisture as weight loss divided by sample weight as in oven technique.

Note: Several trial runs need to be made to calibrate procedure to requirements of sample and microwave oven. Vary oven heat level and dwell time to optimize drying rate. BE SURE TO DRY TO CONSTANT WEIGHT and DO NOT BURN OR SMOKE SAMPLE.

C. SALT ANALYSIS

1. Place exactly 10 grams of sample in a 250 ml beaker.

2. Add 90 mls (or 90 grams) of boiling distilled water. Use boiling tap water only if a test with a Quantab shows the tap water to be salt free.

3. Stir for 30 seconds, wait one minute (or longer if particles are large), and stir another 30 seconds to insure all salt is extracted from sample.

4. Place salt titrator in sample (enclosed in filter paper) as prescribed in titrator instructions and read value from titrator. Look up percent salt of solution from calibrations chart.

5. Compute percent salt of sample by multiplying percent salt in diluted solution by the dilution factor of 10. If the salt level reads off the scale, then dilute the solution 50/50, test with another titrator strip, then multiply the result by 20.

D. COMPUTE WATER PHASE SALT CONTENT

$$WPS = \frac{\%\ SALT \times 100}{\%\ MOISTURE + \%\ SALT}$$

Notes on Procedures

a. Osterizer brand food blenders used with small "canning jar" type containers work best because the sample is contained during mixing. Because glass jars might break during blending do not hold glass jar while blender is operating.

b. Any clean containers will suffice for hot water extraction but they must be salt free. Glass is easiest to clean.

c. Clean paper towels will suffice for filter paper if a Quantab test is run to insure that they are salt free.

d. Use a wash (squirt) bottle of distilled water to add the last few milliliters of water to the salt sample.

e. Boiling tap water can be used for extraction in place of distilled water as long as it is shown to be salt free. An easy way to heat a few hundred milliliters of water is with a microwave oven.

f. Be sure to save the sample in the original blending container (refrigerated with lid on) until the results are accepted.

g. If the salt content of diluted solution is so high that the titrator strip goes off scale, simply dilute the solution 50/50, test with another titrator strip, and then multiply the result by a dilution factor of 20.

SUMMARY OF REQUIREMENTS FOR LOWEST EQUIPMENT COST PROCEDURE.

Chloride titrators (bottle of 50)	26.50
glass fiber sample pads (400)	34.00
Osterizer food blender	30.00
Triple beam mechanical balance	110.00
Blending jars (6)	13.00
small food jars (6 x about 250 ml)	0.00
Graduate cylinder, 250 ml	12.00
wash bottle, plastic	2.00
salt free tap water	0.00
clean paper towels	2.00
small micro wave carousel oven	120.00
total	349.50

The minimum investment for salt and moisture analysis should be less than $350, including the cost of a small carousel type microwave oven. At 53 cents per titrator, 17 cents for two sample pads, plus a few cents for miscellaneous supplies, the cost per test will run about $.75 each.

USE OF SALT CHARTS AND GRAPHS

Use Chart I to estimate how much salt must be in raw brined fish (55% to 80% raw brined moisture) to give 3.5% WPS in finished product (40% to 80% final moisture). Chart II simply shows the WPS which would correspond to various moisture and salt contents calculated by the formula:

WPS = %salt divided by %salt + % moisture x 100.

Graphs I, II, and III give the same information (but more detailed on three different scales) for various WPS contents over a broader range of beginning and ending moisture contents.

Chart III, as does Chart I, shows the relationship between beginning and ending moisture and salt contents for a final WPS of 3.5%. The difference between the two charts is simply the complexity of numbers and ranges. Graph IV plots the same information as Chart III over the same range of moisture contents.

CHART I

RAW BRINED FISH SALT CONTENT NEEDED TO ACHIEVE 3.5 % WATER PHASE SALT (WPS) AT VARIOUS FINAL MOISTURE CONTENTS

	MOISTURE CONTENT OF RAW BRINED FISH						
Final Moisture	55%	60%	65%	70%	75%	80%	
40%	1.09	.96	.85	.72	.60	.48	
45%	1.33	1.18	1.03	.89	.74	.59	
50%	1.63	1.44	1.27	1.09	.91	.72	
55%	1.99	1.76	1.55	1.33	1.11	.88	
60%		2.18	1.91	1.61	1.36	1.09	x
65%			2.36	2.03	1.69	1.35	
70%				2.54	2.12	1.69	
75%					2.72	2.18	
80%						2.90	

To predict final WPS in a finished product you must first conduct a salt and moisture test of the raw brined or salted fish and know the final moisture content of the product you wish to produce. For example, a raw brined fish with 80% moisture and 1.09% salt (see line with x at the end) will have 3.5% WPS when dried to 60% final moisture. Anything less than 1.09 % salt will not produce 3.5% WPS in a product which is finished to 60 % moisture

CHART II

MOISTURE LEVELS IN RAW FISH v.s. PERCENT SALT & PERCENT WPS

	% moisture															
WPS	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	WPS
	% salt															
2.0	0.31	0.41	0.51	0.61	0.71	0.82	0.92	1.02	1.12	1.22	1.33	1.43	1.53	1.63	1.73	2.0
3.0	0.46	0.62	0.77	0.93	1.08	1.24	1.39	1.55	1.70	1.86	2.01	2.16	2.32	2.47	2.63	3.0
3.5	0.54	0.73	0.91	1.09	1.27	1.45	1.63	1.81	1.99	2.18	2.36	2.54	2.72	2.90	3.08	3.5
4.0	0.63	0.83	1.04	1.25	1.46	1.67	1.88	2.08	2.29	2.50	2.71	2.92	3.13	3.33	3.54	4.0
5.0	0.79	1.05	1.32	1.58	1.84	2.11	2.37	2.63	2.89	3.16	3.42	3.68	3.95	4.21	4.47	5.0
6.0	0.96	1.28	1.60	1.91	2.23	2.55	2.87	3.19	3.51	3.83	4.15	4.47	4.79	5.11	5.43	6.0
7.0	1.13	1.51	1.88	2.26	2.63	3.01	3.39	3.76	4.14	4.52	4.89	5.27	5.65	6.02	6.40	7.0
8.0	1.30	1.74	2.17	2.61	3.04	3.48	3.91	4.35	4.78	5.22	5.65	6.09	6.52	6.96	7.39	8.0
9.0	1.48	1.98	2.47	2.97	3.46	3.96	4.45	4.95	5.44	5.93	6.43	6.92	7.42	7.91	8.41	9.0
10.0	1.67	2.22	2.78	3.33	3.89	4.44	5.00	5.56	6.11	6.67	7.22	7.78	8.33	8.89	9.44	10.0
11.0	1.85	2.47	3.09	3.71	4.33	4.94	5.56	6.18	6.80	7.42	8.03	8.65	9.27	9.89	10.51	11.0
12.0	2.05	2.73	3.41	4.09	4.77	5.45	6.14	6.82	7.50	8.18	8.86	9.55	10.23	10.91	11.59	12.0
13.0	2.24	2.99	3.74	4.48	5.23	5.98	6.72	7.47	8.22	8.97	9.71	10.46	11.21	11.95	12.70	13.0
14.0	2.44	3.26	4.07	4.88	5.70	6.51	7.33	8.14	8.95	9.77	10.58	11.40	12.21	13.02	13.84	14.0
15.0	2.65	3.53	4.41	5.29	6.18	7.06	7.94	8.82	9.71	10.59	11.47	12.35	13.24	14.12	15.00	15.0
16.0	2.86	3.81	4.76	5.71	6.67	7.62	8.57	9.52	10.48	11.43	12.38	13.33	14.29	15.24	16.19	16.0
17.0	3.07	4.10	5.12	6.14	7.17	8.19	9.22	10.24	11.27	12.29	13.31	14.34	15.36	16.39	17.41	17.0
18.0	3.29	4.39	5.49	6.59	7.68	8.78	9.88	10.98	12.07	13.17	14.27	15.37	16.46	17.56	18.66	18.0
19.0	3.52	4.69	5.86	7.04	8.21	9.38	10.56	11.73	12.90	14.07	15.25	16.42	17.59	18.77	19.94	19.0
20.0	3.75	5.00	6.25	7.50	8.75	10.00	11.25	12.50	13.75	15.00	16.25	17.50	18.75	20.00	21.25	20.0

CHART III
RELATIONSHIP BETWEEN BEGINNING AND FINAL MOISTURE IN SMOKED FISH FROM 15 TO 80% SOLIDS AND 3.5% FINAL WATER PHASE SALT

FINAL			BEGINNING		
MOISTURE	SOLIDS	%SALT	MOISTURE	SOLIDS	%SALT
15	85	0.54	20	80	0.51
15	85	0.54	25	75	0.48
20	80	0.73	25	75	0.68
15	85	0.54	30	70	0.44
20	80	0.73	30	70	0.64
25	75	0.91	30	70	0.85
15	85	0.54	35	65	0.41
20	80	0.73	35	65	0.59
25	75	0.91	35	65	0.79
30	70	1.09	35	65	1.01
15	85	0.54	40	60	0.38
20	80	0.73	40	60	0.55
25	75	0.91	40	60	0.73
30	70	1.09	40	60	0.93
35	65	1.27	40	60	1.17
15	85	0.54	45	55	0.35
20	80	0.73	45	55	0.50
25	75	0.91	45	55	0.67
30	70	1.09	45	55	0.86
35	65	1.27	45	55	1.07
40	60	1.45	45	55	1.33
15	85	0.54	50	50	0.32
20	80	0.73	50	50	0.46
25	75	0.91	50	50	0.61
30	70	1.09	50	50	0.78
35	65	1.27	50	50	0.98
40	60	1.45	50	50	1.21
45	55	1.63	50	50	1.48
15	85	0.54	55	45	0.29
20	80	0.73	55	45	0.41
25	75	0.91	55	45	0.55
30	70	1.09	55	45	0.70
35	65	1.27	55	45	0.88
40	60	1.45	55	45	1.09
45	55	1.63	55	45	1.33
50	50	1.81	55	45	1.63

CHART III, cont.

FINAL			BEGINNING		
%MOISTURE	%SOLIDS	%SALT	%MOISTURE	%SOLIDS	%SALT
15	85	0.54	60	40	0.25
20	80	0.73	60	40	0.37
25	75	0.91	60	40	0.49
30	70	1.09	60	40	0.62
35	65	1.27	60	40	0.78
40	60	1.45	60	40	0.97
45	55	1.63	60	40	1.19
50	50	1.81	60	40	1.45
55	45	1.99	60	40	1.77
15	85	0.54	65	35	0.22
20	80	0.73	65	35	0.32
25	75	0.91	65	35	0.42
30	70	1.09	65	35	0.55
35	65	1.27	65	35	0.68
40	60	1.45	65	35	0.85
45	55	1.63	65	35	1.04
50	50	1.81	65	35	1.27
55	45	1.99	65	35	1.55
60	40	2.18	65	35	1.91
15	85	0.54	70	30	0.19
20	80	0.73	70	30	0.27
25	75	0.91	70	30	0.36
30	70	1.09	70	30	0.47
35	65	1.27	70	30	0.59
40	60	1.45	70	30	0.73
45	55	1.63	70	30	0.89
50	50	1.81	70	30	1.09
55	45	1.99	70	30	1.33
60	40	2.18	70	30	1.64
65	35	2.36	70	30	2.02
15	85	0.54	75	25	0.16
20	80	0.73	75	25	0.23
25	75	0.91	75	25	0.30
30	70	1.09	75	25	0.39
35	65	1.27	75	25	0.49
40	60	1.45	75	25	0.60
45	55	1.63	75	25	0.74
50	50	1.81	75	25	0.91
55	45	1.99	75	25	1.11
60	40	2.18	75	25	1.36
65	35	2.36	75	25	1.69
70	30	2.54	75	25	2.12

CHART III, cont.

FINAL			BEGINNING		
MOISTURE	SOLIDS	%SALT	MOISTURE	SOLIDS	%SALT
15	85	0.54	80	20	0.13
20	80	0.73	80	20	0.18
25	75	0.91	80	20	0.24
30	70	1.09	80	20	0.31
35	65	1.27	80	20	0.39
40	60	1.45	80	20	0.48
45	55	1.63	80	20	0.59
50	50	1.81	80	20	0.72
55	45	1.99	80	20	0.88
60	40	2.18	80	20	1.09
65	35	2.36	80	20	1.35
70	30	2.54	80	20	1.69
75	25	2.72	80	20	2.18
15	85	0.54	85	15	0.10
20	80	0.73	85	15	0.14
25	75	0.91	85	15	0.18
30	70	1.09	85	15	0.23
35	65	1.27	85	15	0.29
40	60	1.45	85	15	0.36
45	55	1.63	85	15	0.44
50	50	1.81	85	15	0.54
55	45	1.99	85	15	0.66
60	40	2.18	85	15	0.82
65	35	2.36	85	15	1.01
70	30	2.54	85	15	1.27
75	25	2.72	85	15	1.63
80	20	2.90	85	15	2.18

CHART I - WATER PHASE SALT vs RAW SALT CONTENT
At 15 to 85 % Raw Moisture Content

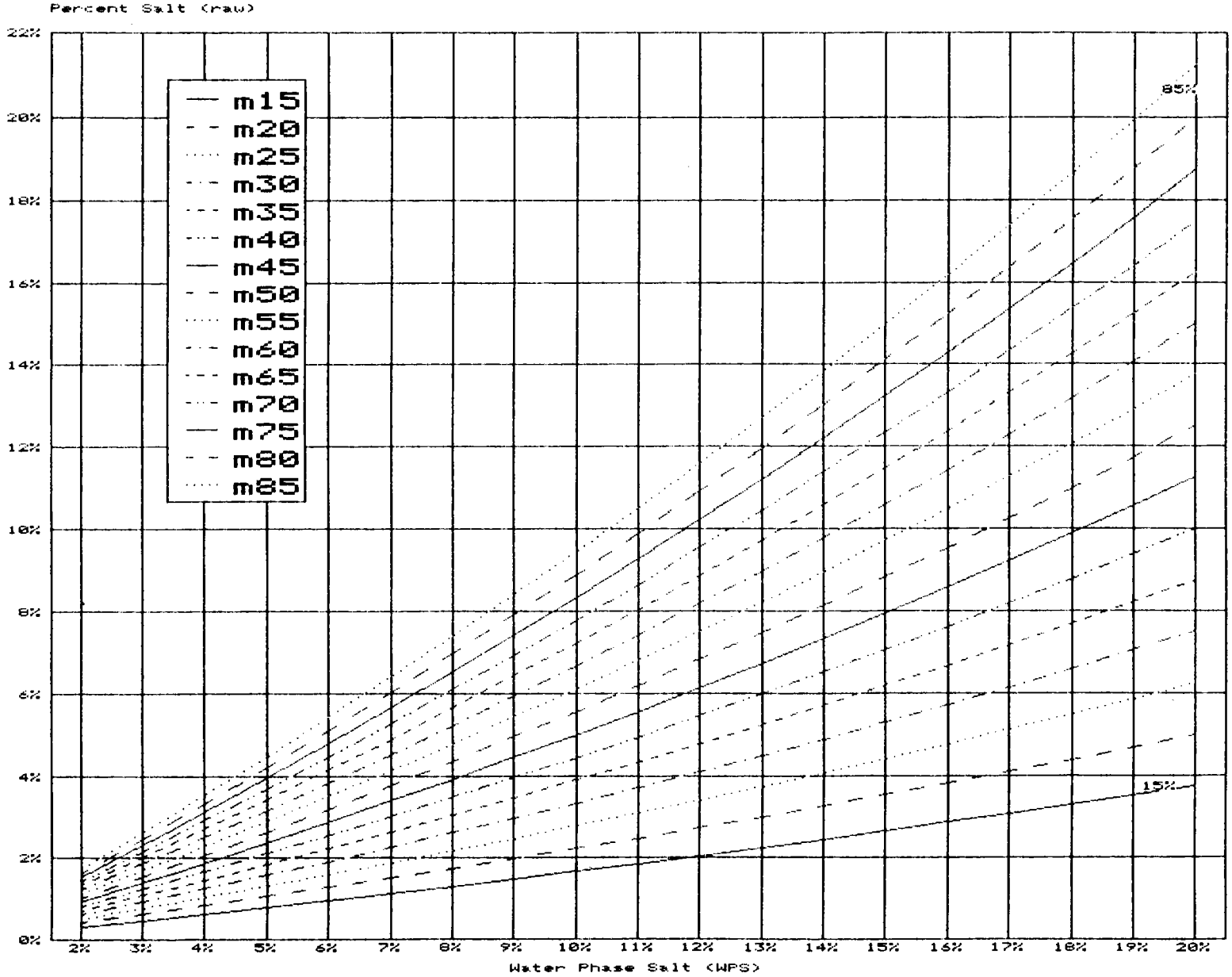


CHART II – WATER PHASE SALT vs RAW SALT CONTENT AT 15 TO 85% RAW MOISTURE CONTENT (2 to 10% wps)

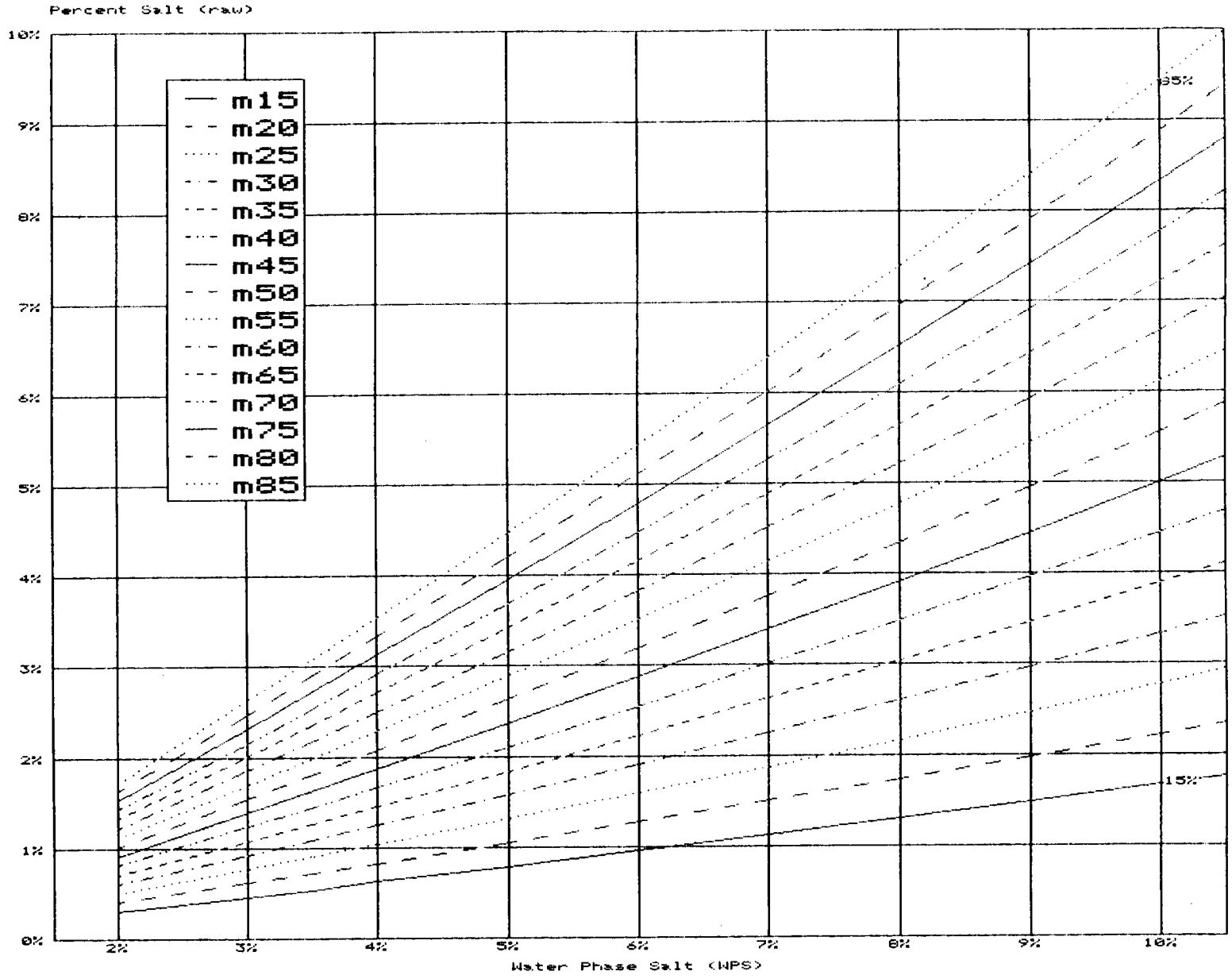
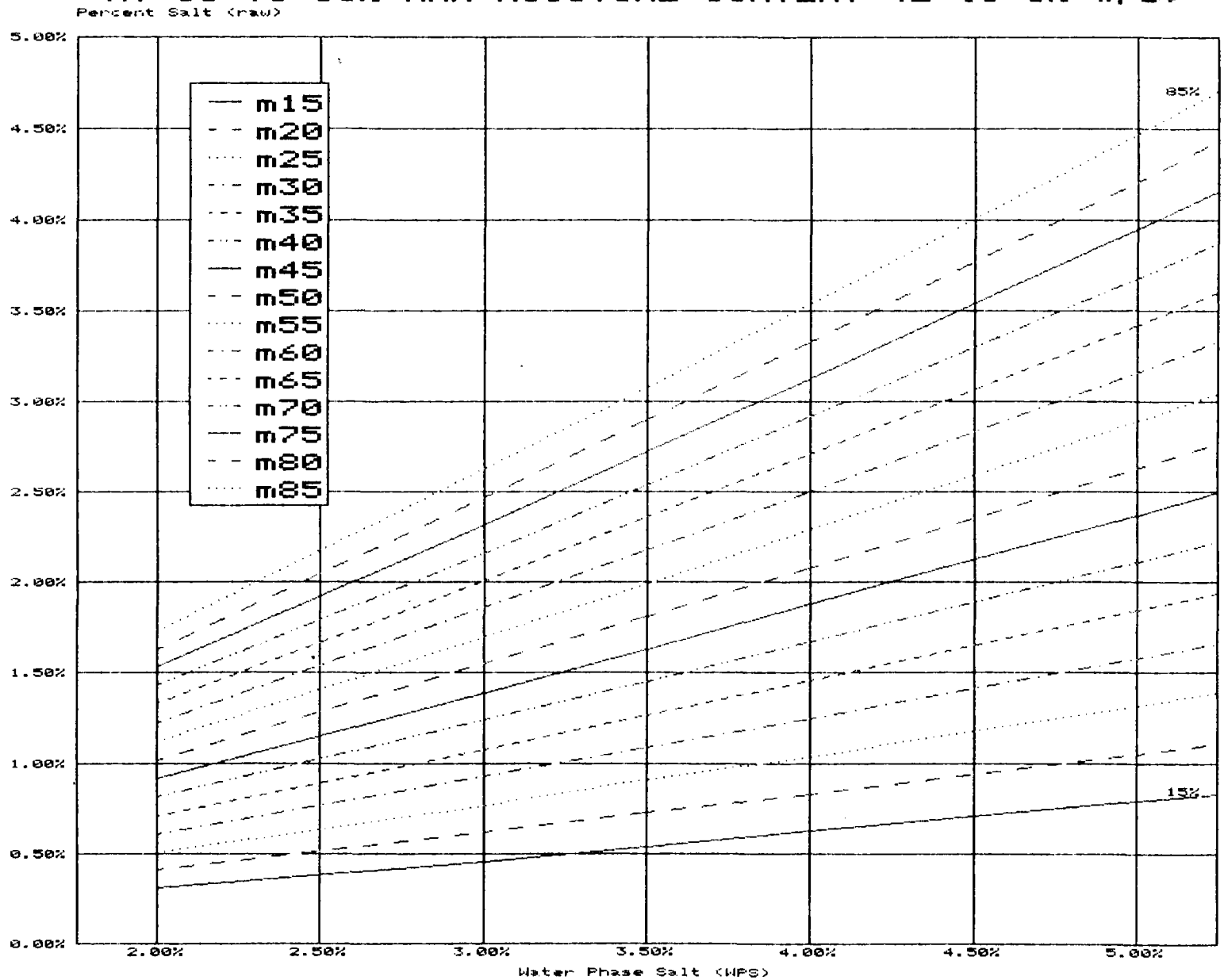


CHART III – WATER PHASE SALT vs RAW SALT CONTENT AT 15 TO 85% RAW MOISTURE CONTENT (2 to 5% wps)



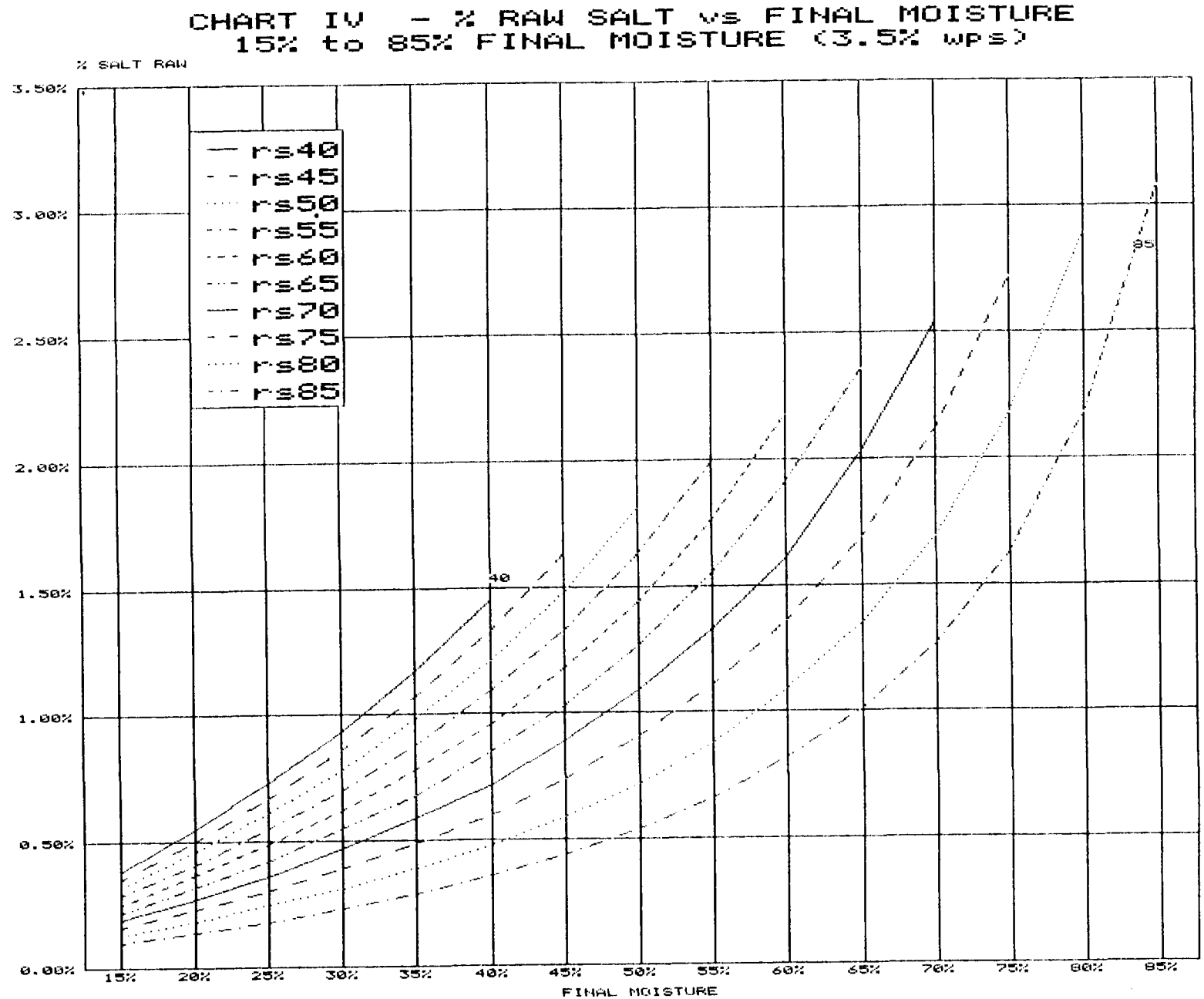


CHART IV - % RAW SALT vs FINAL MOISTURE
15% to 85% FINAL MOISTURE (3.5% wps)
% SALT RAW
3.50%
3.00%
2.50%
2.00%
1.50%
1.00%
0.50%
0.00%
rs40
rs45
rs50
rs55
rs60
rs65
rs70
rs75
rs80
rs85
40
85
15%
20%
25%
30%
35%
40%
45%
50%
55%
60%
65%
70%
75%
80%
85%
FINAL MOISTURE

The Extension Sea Grant Program, a component of the OSU Extension Service, provides education, training, and technical assistance to people with ocean-related needs and interests.

Extension Service, Oregon State University, Corvallis, O.E. Smith, director. This publication was produced and distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914. Extension work is a cooperative program of Oregon State University, the U.S. Department of Agriculture, and Oregon counties.

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