PHOSPHATE TREATMENT OF FROZEN PRAWNS

I. SCREENING OF VARIOUS PHOSPHATES FOR PREVENTION OF DRIP LOSS

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Various phosphates and their mixtures were screened for their efficiency of preventing drip loss in frozen prawns. The effectiveness of the phosphates decreased in the following order: Sodium tripolyphosphate – Sodium pyrophosphate – Sodium hexametaphosphate Sodium metaphosphate – Sodium dihydrogen phosphate; the last two being ineffective. Even though thaw drip loss was reduced by the above treatments the organoleptic quality of the thawed as well as cooked products was unsatisfactory, discolouration being the major defect. A solution of a mixture of 12% sodium tripolyphosphate and 8.6% sodium dihydrogen phosphate or 2% citric acid in water when used as dip prevented thaw drip loss, improved cooked yield and organoleptic quality without adversely affecting the biochemical characteristics. Commercial scale trials showed that the results are highly reproducible.

INTRODUCTION

Drip losses from frozen prawns are considerable, being approximately 5% in headless, 10% in peeled and deveined and 3% in cooked prawns (Pillai, unpublished). To compensate for this loss the processors add 120-360 grams more prawns to every 2.27 Kg of the material frozen. The losses from the excess weight of prawns added work out to 1,000 tons on the basis that 10,000 tons are exported per annum. More than the material loss drip also results in loss of flavour and texture. Therefore methods of prevention of drip formation are of paramount importance to the prawn processing industry.

Bendal (1954, 1958) reported the effect of polyphosphates on the contractile protein actomyosin of meats and the resultant effect of such a reaction on the water binding capacity of meat. The effectiveness of polyphosphates (Tanikawa, 1963) Sodium hexametaphosphate (Heen 1954; Buttukus and Tarr, 1952) and Sodium tripolyphosphate (Mahon, 1962; Dyer, *etal* 1964; Mac Callum, 1964; Boyd and South-

cott, 1965) for preventing drip loss from frozen fish has been demonstrated. However, there is no report on the application of these chemicals to frozen prawns. Therefore it was considered worth trying these chemicals in frozen prawns to maintain correct thawed weight.

This report deals with the screening of various phosphates and their mixtures as dip solution for maintenance of correct thawed weight in frozen prawns. An effective phosphate composition has been worked out and the effect of the treatment on thawed and cooked yields and on biochemical and organoleptic characteristics has been studied.

Experimental

In the experiments prawns of the species *P. Indicus, M. affinis, M. Dobsoni, and P. stylifera* were used in the peeled and deveined form. All the phosphates used for treatment were of laboratory reagent or commercial grade. The volume of the dip solution was 60% of the weight of the material and dipping time was two minutes. The dip treated materials were drained for three minutes, frozen at -40°C and stored at -18°C till analysed. A water dipped sample processed under identical conditions served as the control. Analyses were carried out within three days of freezing. Thawing was done in running water at room temperature after sealing the blocks (450 g) in watertight polythene bags. After thawing they were drained for ten minutes and cooked in 3% boiling brine (150 ml for 100 g) for ten minutes. Moisture and total nitrogen (TN) were determined by the A. O. A. C. method (A. O. A. C. 1960), water extractable nitrogen WEN and nonprotein nitrogen (NPN) as described by Govindan (1962), free α-amino nitrogen (α-NH_2 -N) by the method of Pope and Stevens (1939), salt solubility (SS) and myosin nitrogen (MN) by the method of Dyer *et al* (1960) and inorganic phosphorus in trichloracetic acid extracts by the method of Fiske and Subba Raw (1925.)

Results

Sodium dihydrogen phosphate (SDP), Disodium phosphate (DSP), Trisodium phosphate (TSP), Sodium metaphosphate (SMP), Sodium hexametaphosphate (SHMP), Sodium pyrophosphate (SPP). Sodium tripolyphosphate (STPP) and their mixtures were tried as dip at 2, 4, 8 and 12%. The results on thawed yields, cooked yields, moisture, and phosphorus up take are shown in Figures 1 to 4.

A comparison of the various phosphates, a phosphate mixture and 'Freeze-Gard' a patented imported substance is given in Table I with statistical treatments of data on thawed and cooked yields, increase in weight during dip, moisture content and the pH of the solutions and treated muscle. Analyses of the comparative data on the effect of STPP neutralised with SDP or citric acid (2%) and 'Freeze-Gard' are shown in Table II while Table III gives the biochemical and organoleptic characteristics of the treated prawns.

The statistical analysis of changes in the volume of raw material, after dip treatment, after thawing and after cooking is given in Table IV.

Results of commercial trials carried out in the factory are given in Table V.

Discussion

From Fig. I it is clear that the thawed yield is higher by 8-10% when treated with more than 8% solution of DSP, TSP, SHMP, SPP and STPP while no improvement was observed in treatments with SMP and SDP. The same observation holds good in the case of cooked yield also

as is clear from Fig. 2. It can also be seen that the effectiveness is in the following decreasing order: STPP - SPP - DSP - TSP SHMP - SMP - SDP. Of the effective phosphates all except SHMP are alkaline and the organoleptic characteristics of the thawed as well as cooked products are unsatisfactory, dicolouration being the most notable defect. SHMP treated sample was superior in colour to others which gave the clue that alkalinity of the solutions is the cause of the discolouration. Neutral solutions of some of the phosphates viz. SDP, DSP and TSP were ineffective in maintaining correct weight. STPP (12%) neutralised with SDP (8.6%) or citric acid (CA) (2%) was found to retain the effectiveness and to improve the organoleptic characteristics, From Table I it can be noted that almost all the dips increased the weight after dipping but the absorbed water is lost during thawing in majority of the cases. Also from Fig. 3 it can be noted that the moisture in the final product is almost constant in the effective cases, while it decreases in the ineffective cases. This increase in thawed yield without increase in moisture is explained by simultaneous absorption of water and solids by the tissue keeping their proportion constant. Table I shows that the effectiveness of the treat ment decreases as follows. (STPP-Freeze Gard) - (STPP+ SDP, DSP, SPP)- (SHMP TSP) - control-SMP-SDP. The amount of phosphorus retained by the treated tissue varies between 98 and 359 mg% in the different cases as shown in Fig. 4. By incorporating 8.6% DSP in STPP the amount of phosphorus absorbed is 376 mg % more than when STPP alone is used as is shown in table II, Table II shows tnat the variations between treatments are significant at 0.1% level. The effect of the 4 treatments are significantly different for thawed yield. From tables II and III it is very clear that the formulation consisting of STPP and SDP or citric acid is as good as Freeze-Gard except for the WEN which is only half of the control in these cases but cooked yield is slightly higher for 'freeze-gard'. STPP, STPP + SDP and STPP+CA are similar. The TN values are well comparable as also salt solubility and myosin content.

From Table IV it is clear that the volume after treatment, freezing and thawing is 3-6% higher than control and 14-16% higher after cooking. This indicates the less shrinkage in the phosphate treated samples. The effects of 'Freeze Gard' and STPP+SDP on cooked volumes are not significantly different.

Commercial trials carried out with 2 27 kgs blocks show that the results are highly reproducible as evident from Table V. When 'Freeze-Gard' is used the material becomes more slimy with foam formation and consequent air-space formation in frozen sample. This is avoided in the above formulation and all the factories who tried out the treatment agreed to the usefulness and convenience of the method.

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TABLE I ANALYSIS OF THE DATA ON THE EFFECT OF 12% SOLUTION OF VARIOUS PHOSPHTES ON FROZEN PRAWNS

	Thawed Yield			*Cooked Yield*			*pH of Dipped Muscle*			*Moisture %*			*% Wt after dip*		
	SS	DF	MS	SS	DF	MS	SS	DF	MS	SS	DF	MS	SS	DF	MS
Total	1250.30	21		518.89	21		6.86	21		59.97	21		245.26	19	
Bet. Trials	1.42	1	1.42	00.41	1	0.41	0.24	1	*0.24	5.80	1	**5.80	15.84	1	**15.84
Bet. Treatments	1241.07	10	***124.107	506.09	10	***50.609	6.35	10	***0.635	52.64	10	***5.264	219.37	9	***24.37
Error	7.81	10	0.781	12.09	10	1.209	0.27	10	0.027	1.53	10	0-153	10.05	9	1.12

C. D = 1.969	C. D = 2.450	C. D = 0.366	C. D = 0.8716	C. D = 2.394
Treatment means:	Treatment means:	Treatment means:	Treatment means:	Treatment means:
SDP = 77.35	SDP = 54.0	SDP = 6.65	SDP = 80.35	SDP = 97.00
DSP = 100 00	DSP = 65.5	DSP = 8.30	DSP = 84.70	DSP = 103.50
TSP = 97.85	TSP = 64 0	TSP = 8.20	TSP = 84.05	TSP = 101.65
SMP = 85.50	SMP = 58.5	SMP = 7.60	SMP = 82 80	SMP = 98.70
SHMP = 97.35	SHMP = 58.5	SHMP = 7.15	SHMP = 81.80	SHMP = 100.75
SPP = 99.75	SPP = 66.0	SPP = 8,50	SPP = 85.10	SPP = 104.00
STPP = 103.15	STPP = 66 0	STPP = 7.75	STPP = 84.35	STPP = 103.90
STPP + SDP = 100 50	STPP + SDP = 61.0	STPP + SDP = 7.00	STPP + SDP = 83.10	STPP + SDP = 100.50
Freeze Gard = 101.50	Freeze Gard = 58.5	Freeze Gard = 7.50	Freeze Gard = 86.20	Freeze Gard = 108.50
Dipped cont = 93.75	Dipped cont. = 53.0	Dipped Cont. = 7.75	Dippped Cont. = 84.45	Dipped Cont. = 106.50
Undipped cont. = 90.80	Undipped cont. = 53.5	Undipped cont. = 7.75	Undipped cont. = 83.75	

* Significance at 5% level.
** Significance at 1% level.
*** Significance at 0.1% level.

TABLE II ANALYSIS OF VARIANCE OF DATA ON EFFECT OF NEUTRALISED STPP AND 'FREEZE-GARD' ON PRAWNS.

	Thawed Yield			*CookedYield*			*Moisture*			*P.mg%*		
	SS	DF	MS	SS	DF	MS	SS	DF	MS	SS	DF	MS
Total	258.7495	19		476.95	19		46.31	19		288236.95	19	
Bet.Trials	17.4999	3	*5.8333	17.75	3	5.92	27.72	3	*9.24	1401.75	3	467.25
Bet.Treatments	231.5157	4	***57.8789	435.70	4	***108.925	9.22	4	2.305	285124.70	4	***71281.75
Error	9.7339	12	0.8112	23.50	12	1.960	9.37	12	0.781	1710.50	12	142.540
	CD = 1.388			CD = 2.157						CD = 18.27		
	Treatment means:			*Treatment means:*						*Treatment means:*		
Control	93 22			53.00						198.0		
STPP 12%	102.165			65.75						321.25		
STPP 12%+CA 2%	101.175			64.50						335.25		
STPP 12%+ SDP 8.6%	101.825			64.75						567.00		
'Freeze Gard' 10% Soln., 40. ml/lb	101.585			62.25						341.25		

* Significance at 5% level.
** Significarce at 1% level.
*** Significance at 0.1% level.

TABLE III BIOCHEMICAL CHARACTERISTICS OF THE PHOSPHATE TREATED SAMPLES

Sl. No.	Treatment	TN MgN/ 100 g raw material	WEN % TN	SS %TN	MN %TN	∝-NH_2N mg/100g	NPN mg/100 g	Organoleptic quality.
1.	Control	2322	31.25	85.35	39.8	52.6	186.0	Fair, dried apparance
2.	STPP 12%	2375	44.16	84.34	41.2	90.7	169.8	Fair like cartilage
3.	STPP12%+CA2%	2355	15.36	80.07	39.7	—	154.0	
4.	STPP 12% + SDP 8.6 %	2412	17.03	85.15	44.1	84.0	165.0	Fair, pleasing appearance
5.	Freeze-Gard (10% Soln. 40 ml/454 g)	2409	25.86	85.40	38.5	60.2	158.0	

TABLE IV ANALYSIS OF VARIANCE OF DATA ON CHANGES IN THE VOLUME OF PRAWNS BY PHOSPHATE TREATMENT

	Dipped Product			*Thawed Product*			*Cooked Product*		
	SS	DF	MS	SS	DF	MS	SS	DF	MS
Total	153.77	11		58 40	11		408.75	11	
Bet. Trials	23 65	3	**7.883	4.42	3	*1.47	0.51	3	0.170
Bet. Treatments	127.19	2	***63.595	53.08	2	***26.54	397.23	2	***198.620
Error	2.93	6	0.488	0.90	6	0.15	11.01	1	1.835

CD = 0.97	CD = 0.6702	CD = 2.344
Treatment means:	Treatment means	Treatment means:
i) 102 250	i) 96.1	i) 43.0
ii) 94.375	ii) 99.7	ii) 55.4
iii) 99.400	iii) 101.1	iii) 55.0

TABLE V REPRODUCIBILITY OF THE RESULTS BY PHOSHHATE TREATMENT UNDER COMMERCIAL CONDITIONS*

Sl. No.	Treatment	Thawed yield %	Cooked Yield %	Remarks
1.	Water	94.27	52.5	Dried up appearance of thawed as well as cooked product
2.	STPP + SDP (500 ml/2.27 Kg)	102.30	70.0	Thawed and cooked products are more appealing in colour, appearance and flavour.
3.	Freeze-Gard (10% soln. 40 ml./ 454 g.)	103.20	67-0	

* Average of 10 trials.

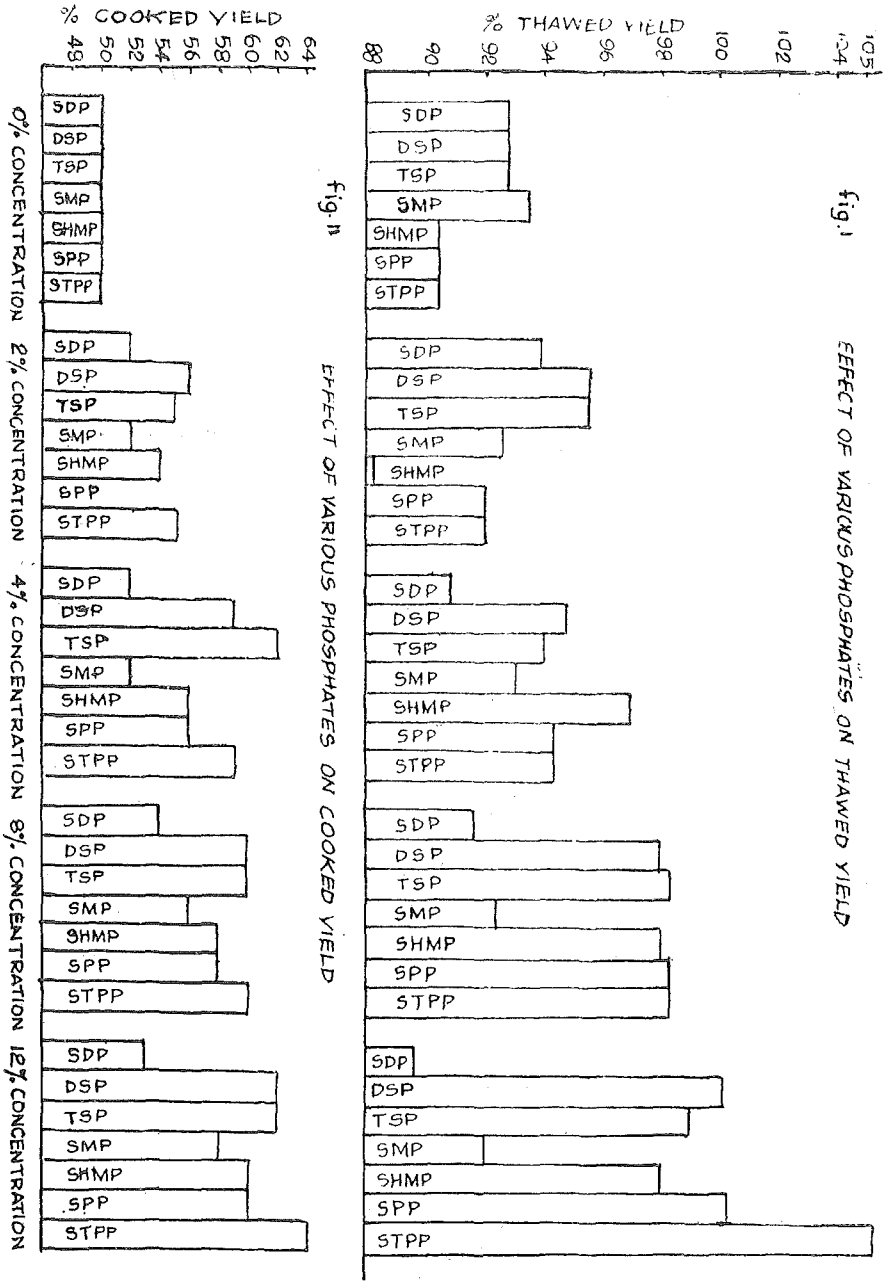

fig. I EFFECT OF VARIOUS PHOSPHATES ON THAWED YIELD

fig. II EFFECT OF VARIOUS PHOSPHATES ON COOKED YIELD

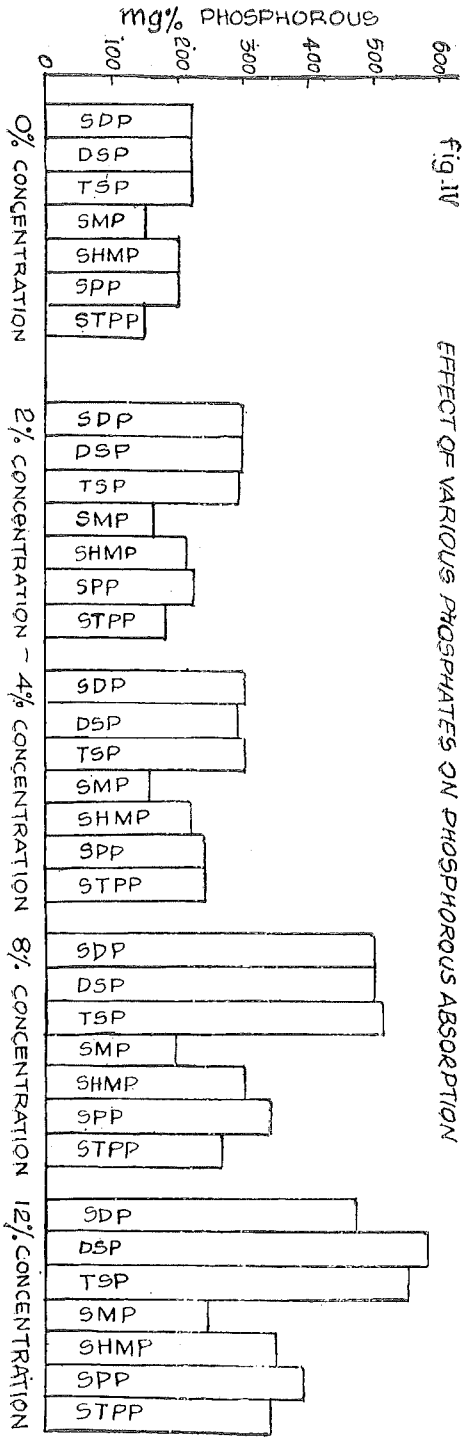

fig. IV EFFECT OF VARIOUS PHOSPHATES ON PHOSPHOROUS ABSORPTION

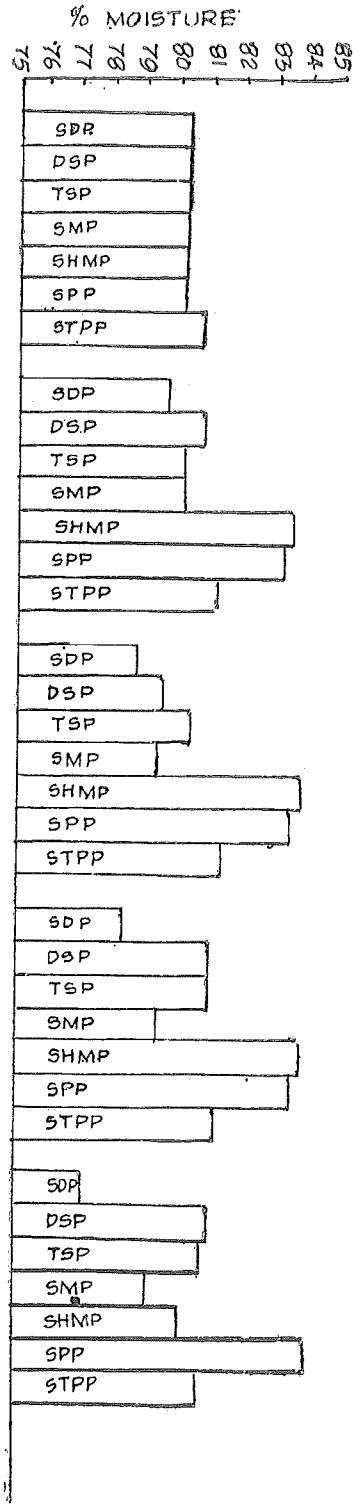

fig. III EFFECT OF VARIOUS PHOSPHATES ON MOISTURE RETENTION

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