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Effect of Incorporation of Frozen Stored Minced Fish on the Quality of Gelatinized Product from Rice and Maize Flour

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Fish mince was prepared using pink perch (*Nemipterus japonicus*) meat and frozen stored at –30°C. Mince was mixed with rice flour and maize flour at 5%, 10%, 20% and 30% level and gelatinized using twin screw extruder in the temperature range of 80,90,100 and 110°C. Frozen stored mince was drawn at 30 days interval upto 120 days and products were prepared. Gelatinized products were analysed for its chemical composition, biochemical, functional, organoleptical and microbiological status and the results are presented. From the results it is found that, gelatinized products prepared using minced meat stored at –30°C for 120 days does not show any significant change in the over all quality for acceptance.

Key words : Fish mince, frozen storage, Pink perch, Gelatinized products, quality

Extrusion cooking is the process of forcing a material to flow under a variety of conditions through a shaped hole (die) at a pre-determined rate to achieve various resulting products (Dziezak, 1989). It is a high temperature short residence time (HTST) process by which moistened starchy and proteinaceous materials are plasticised and cooked in a tube by a combination of higher pressure, intense mechanical shear and heat to create fabricated, shaped products of varying texture (Smith, 1971). Twin screw extruders are increasingly used for production of a variety of food products because they are operational at very low feed moisture requiring no or minimum post extrusion drying (Dziezak, 1989; Harper, 1979). The extruder with two screws of intermeshing flights has an enhanced capacity for conveying mixing, heat transfer and viscous dissipation of mechanical energy input. They are able to handle sticky materials from which gelatinized products can be developed. Extrusion cooking is a versatile processing technique for the development of fabricated or textured foods. It is employed to produce expanded fish snacks or crackers (Yu *et. al.*, 1981; Maga and Reddy, 1985), fish fingers or stick (Lee, 1986), Crab sticks, shrimp analogues or marine beef, protein gels (Suzuki, 1981; Kristensen *et. al.*, 1984; Megard *et. al.*, 1985; Mandigo, 1986). The role of extrusion was initially limited to mixing and forming of cereal products. Extrusion of protein, specially related to seafood, has achieved only limited success. Suja and Basu (1998) attempted to prepare a ready to cook extruded fish product. The potential of extrusion cooking to

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produce textured protein from seafood is yet to be exploited. To develop any new product, it is essential to know their storage characteristics. In the present investigation gelatinized products were prepared using frozen stored minced fish meat with rice flour and maize flour and their properties were studied.

Materials and Methods

The extrusion was performed with counter rotating twin screw extruder (model DSE 35/12D M/s Brabender, Germany) powered with 8.5 Kw was used for product development. Pink perch, *Nemipterus japonicus* (80-250g size) procured from the Thoothukudi fishing harbour in iced condition and brought to the laboratory for further studies. Fishes were beheaded, eviscerated, washed and fed into a mechanical deboner (Baader, 601) to obtain mince. Minced meat was washed with chilled water (4°C) for 4 times (1:5 ratio of meat to water) to remove water-soluble proteins, enzymes, blood etc. The excess water was removed by squeezing in a muslin cloth. The washed minced meat contained 88% moisture, 9.4% protein, 0.79% fat, 1.4% ash. It was equally divided and packed in laminated low-density poly bag of 400m thickness, frozen using commercial plate freezer (operating temperature –40°C for 90min) and stored in ultra low temperature deep freezer (temperature –30°C). Frozen stored fish mince was drawn at 30 days interval and mixed with rice flour and maize flour at varying compositions produce gelatinized products (Table1). These products were fried in oil and the panel of judges assessed its organoleptic quality.

Table 1. Composition of the gelatinized products

Fish meat	RF Rice flour	MF Maize flour	Added water	Salt
(%)	(%)	(%)	(%)	(%)
0	100%	100%	20	2
5	95%	95%	20	2
10	90%	90%	15	2
20	80%	80%	10	2
30	70%	70%	0	2

The rice flour used in the present study contains 8.30% moisture, 8.7% protein, 1.2% fat, 2.3% ash and 79.2% starch where as maize flour contains 8.7% moisture, 9.5% protein, 1.2% fat, 2.6% ash and 77.6% starch. The extruder was operated at conditions such as, feeding rate 0.2g/min, barrel temperature 80, 90, 100 and 110°C in each heating zone and screw speed 85-90 rpm. The ingredients were mixed and kept in refrigerated condition (3 hours) for equilibration. The above mixture was passed through the twin screw extruder (Counter rotating twin screw extruder). The residence time was found to be 160sec. After extrusion, the product was dried at room temperature. The physical and functional quality of extrudates prepared were analysed

Moisture, protein, fat and ash contents of the extrudates were determined (AOAC, 1995). Starch content was estimated by the method of Hodge & Hofreiter, (1962). Expansion ratio and bulk density were determined (Gogoi *et. al.*, 1996). Expansion ratio of the extrudate was estimated after drying and oil frying. It was calculated by dividing the diameter of the extrudate by die diameter. Vernier caliper was used for the measurements, which has a precision of 0.01 mm. The bulk density of the product was calculated as mass / volume of extrudate (kg/m^3). Water Absorption Capacity (WAC) and Fat Absorption Capacity (FAC) of the products were determined (Sosulski, 1962) by keeping 1g of each pulverized sample in a centrifuge tube mixed with 10ml of water and the contents were vortexed for 5min., left at ambient conditions for 30minutes and

Table 1. Changes in the proximate composition of gelatinized products prepared using frozen minced meat (after extrusion and drying)

Fish mince (%)	Base	0 Month Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Starch (%)	II Month Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Starch (%)	IV Month Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Starch (%)
0%	RF	8.40	9.44	1.12	1.56	43.42	10.48	9.60	1.10	1.56	51.87	8.41	9.44	1.10	1.85	43.42
	MF	9.84	10.36	1.03	2.04	59.40	9.92	10.35	0.98	2.10	55.54	11.25	9.44	1.18	2.34	48.00
5%	RF	8.46	9.86	1.13	1.56	39.00	9.72	10.84	1.14	1.64	46.70	8.89	9.86	1.36	2.10	37.58
	MF	9.82	10.94	1.08	2.10	54.45	9.85	10.49	1.10	2.12	52.35	11.14	9.58	1.29	2.46	32.75
10%	RF	9.30	10.45	1.26	1.78	37.58	10.15	10.84	1.25	1.80	41.77	9.30	10.83	1.46	2.19	36.23
	MF	10.81	12.40	1.31	2.51	45.45	10.87	11.38	1.28	2.51	44.54	12.33	10.83	1.39	2.89	34.75
20%	RF	8.89	10.83	1.69	2.20	36.53	10.10	11.15	1.68	2.24	35.60	8.46	11.04	1.85	2.54	33.20
	MF	11.40	12.57	1.49	2.65	42.98	11.50	11.85	1.50	2.78	41.89	13.20	11.26	2.16	3.34	39.00
30%	RF	8.94	11.35	2.83	2.89	33.20	10.59	11.66	2.85	2.94	33.87	8.94	11.45	2.52	3.00	39.00
	MF	11.61	13.35	1.53	3.59	39.03	11.72	12.53	1.54	3.62	39.03	16.60	11.65	2.20	3.86	34.00

RF – Rice flour, MF – Maize flour

centrifuged at 4000 rpm for 10 minutes. The supernatant water was decanted and the weights of the residues with water were observed and recorded. Similarly oil absorption capacity of the extrudates was determined. Gelatinized products were fried in sunflower oil and organoleptic properties were analysed by six member-trained panels (Amerine *et al.*, 1965). The panelists were asked to determine the attribute of quality on the basis of 5-point scale and the results were averaged.

Results and discussion

Gelatinized products were prepared using frozen minced meat at different percentage with rice flour and maize flour. Products were taken out at monthly intervals up to 120 days and analysed for their proximate composition, physical and functional, organoleptic and microbiological properties.

The changes in proximate composition of gelatinized product prepared from rice and maize flour using frozen stored fish mince are presented in Table 1. Extrudates obtained using rice flour and maize flour have a moisture content ranging from 8.4 to 11.61%. Incorporation of minced meat at 10% level increases the amount of protein content in the gelatinized products between 10.84% and 12.40%. When 30% minced meat was added, protein content increases by 11.66 to 13.35%. The increase in the protein content with addition of fish solids probably increased with gelatinization of starch and starch protein interaction. Cross linkage of proteins and development of a protein network have increased the maximum force of hardness. Gelatinized products prepared using rice flour and maize flour are relatively low in fat. Invariably in all the samples protein, fat and ash content shows increasing trend with increased percentage of added minced meat. Similarly the present study shows that starch content was decreased from 51.97 to 33.97 for rice flour and 59.40 to 39.03 for maize flour. Starch content reduced with the addition of minced meat at different percentage. Chew & Yu, (1997) while working on fish starch mixture observed that the temperature range of gelatinization was found to decrease with increase of fish content obtain similar results. The gelatinization of starch is affected by several conditions set in extrusion processing (Chaing & Johnson, 1977).

Changes in physical and functional

Table 2. Changes in physical and functional properties of gelatinized product prepared using frozen stored minced fish (after extrusion and drying)

Fish mince	Base	0 Month				II Month				IV Month			
		Expansion ratio	Bulk density kg/m³	WAC	FAC	Expansion ratio	Bulk density kg/m³	WAC	FAC	Expansion ratio	Bulk density kg/m³	WAC	FAC
0%	RF	1.62	470	3.90	0.61	1.61	468	4.79	0.63	1.67	463	4.79	0.63
	MF	1.23	432	3.27	0.62	1.24	425	3.88	0.90	1.37	406	3.91	0.70
5%	RF	1.48	503	3.60	0.56	1.50	495	3.51	0.62	1.50	494	4.17	0.62
	MF	1.17	461	3.23	0.77	1.18s	456	3.97	0.77	1.27	435	3.88	0.77
10%	RF	1.57	581	4.32	0.66	1.57	534	3.54	0.55	1.40	525	3.54	0.55
	MF	1.07	552	2.87	0.82	1.21	484	4.68	0.77	1.13	468	3.68	0.77
20%	RF	1.50	692	4.20	1.10	1.49	568	3.75	0.72	1.40	560	3.88	0.72
	MF	1.00	665	3.06	0.77	1.10	514	3.23	0.74	1.07	495	3.23	0.77
30%	RF	1.37	804	3.80	0.68	1.27	596	4.17	0.77	1.30	594	3.75	0.77
	MF	0.86	770	2.98	0.84	0.76	545	2.58	0.85	0.97	525	2.50	0.85

RF – Rice flour, MF – Maize flour

properties of gelatinized products using frozen stored minced fish are presented in Table 2. The temperature in the last zone and at the die was required to be ≤ 100°C in order to get flat and bubble free extrudates (Suknark *et. al.*, 1999). In the present study, temperatures of last two zones are 100 and 110°C. Suknark *et. al.*, (1999) have observed that when the temperatures in the last two zone were high, a high screw speed produced bubble formation and partial puffing due to frictional heating. Expansion ratio of the extrudates prepared using rice flour was ranging from 1.62 to 1.37 where as it is 1.23 to 0.86 for maize flour. When the fish percentage increased from 10 to 20% the expansion ratio increased. However, further addition of fish meat decreases the expansion ratio. Similarly Sharma & Basu (2003) have observed that, product prepared using fish flour beyond 30% became hard and the expansion ratio decreased. Decrease in expansion ratio with increasing protein content may be due to protein interaction with starch. The protein binds to the starch matrix in such a way that it increases the thickness of the porous cell walls, thus preventing the release of water on cooking, and preventing expansion of the product. This was because of fact that the expansion of the melted dough at die exist depends upon the extent of gelatinization of starch and the pressure developed. Higher barrel temperature cause more gelatinization and pressure inside the extruder, resulted in expansion at the die exit. Die with a low diameter exerts more exit pressure, which suppresses the flashing of the extrudate. Due to this increased pressure, expansion ratio is reduced, but as the die diameter increases the exit pressure is reduced, this in turn enhances the expansion ratio. Giri & Bandyopadhyay (2000) have observed increased bulk density with increasing temperature and decreasing moisture content. Gogoi *et. al.*, (1996) found that bulk density was unaffected by addition of fish solids up to 30% in rice flour. The decrease in expansion and therefore increase in bulk density with increase in fish content might be attributed to the enhanced protein starch interaction and texturization. Addition of fish improved texture was observed by Murray *et. al.*, (1980). Chinnaswamy & Hanna (1988) found that the bulk density was lower for highly expanded products, and higher for less expanded products. Other workers have also stated that product expansion and bulk density are inversely related (Cumming *et. al.*, 1972; Taranto *et. al.*, 1975; Bhattacharya and Hanna, 1987).Similar results are obtained in the present

Table 3. Changes in the organoleptic quality of gelatinized product (fried) using frozen stored minced meat

Fish mince	Base	0 Month					II Month					IV Month				
		Appearance	Flavour	Crispness	Taste	Overall acceptability	Appearance	Flavour	Crispness	Taste	Overall acceptability	Appearance	Flavour	Crispness	Taste	Overall acceptability
0%	RF	4.92±0.16	4.83±0.37	4.57±0.49	5.0±0.10	5.0±0.00	5.0±0.00	4.83±0.37	4.0±0.00	5.0±0.00	4.5±0.00	4.5±0.05	4.85±0.36	4.67±0.47	4.0±0.00	4.5±0.00
	MF	3.0±0.00	3.65±0.35	2.83±0.27	3.0±0.00	3.0±0.00	2.85±0.10	3.0±0.00	3.0±0.00	3.0±0.00	3.0±0.00	2.7±0.45	3.25±0.50	2.83±0.37	2.5±0.50	3.0±0.00
5%	RF	4.63±0.27	4.83±0.37	4.57±0.49	4.92±0.19	4.92±0.00	3.85±0.37	3.83±0.17	3.83±0.37	4.80±0.40	4.75±0.25	3.11±0.65	3.42±0.57	4.0±0.00	3.0±0.05	3.25±0.25
	MF	2.85±0.15	3.65±0.35	2.83±0.27	2.63±0.18	3.25±0.25	2.67±0.47	3.0±0.00	3.0±0.00	3.0±0.00	3.5±0.00	2.83±0.37	4.0±0.00	2.5±0.50	3.0±0.05	3.0±0.00
10%	RF	3.83±0.37	3.85±0.15	4.25±0.75	4.83±0.37	4.85±0.15	4.5 ±0.00	4.0±0.00	4.0±0.00	4.83±0.37	5.0±0.00	4.5±0.05	4.0±0.00	4.25±0.30	3.0±0.00	4.25±0.50
	MF	3.0±0.10	3.5±0.50	3.5±0.50	2.83±0.27	3.65±0.15	4.0±0.00	3.50±0.00	3.5±0.00	3.0±0.00	3.0±0.38	3.5±0.25	4.0±0.00	3.0±0.00	3.0±0.00	3.25±0.50
20%	RF	3.5±0.50	3.85±0.15	2.92±0.19	3.58±0.45	3.83±0.24	4.0±0.00	4.0±0.00	4.0±0.00	3.58±0.44	4.5±0.00	3.0±0.00	4.0±0.00	3.75±0.50	3.75±0.50	3.0±0.00
	MF	2.85±0.15	2.85±0.15	3.5±0.50	2.5±0.50	3.5±0.50	2.5±0.00	3.0±0.00	3.0±0.00	3.0±0.00	3.5±0.00	2.7±0.45	4.0±0.00	2.0±0.00	3.0±0.00	3.0±0.00
30%	RF	3.25±0.25	2.85±0.15	2.5±0.25	3.5±0.50	3.08±0.19	4.0±0.00	3.5±0.00	3.5±0.00	4.0±0.00	4.0±0.00	3.0±0.00	3.0±0.00	3.0±0.00	2.75±0.25	2.50±0.25
	MF	2.0±0.01	2.5±0.50	2.75±0.25	2.5±0.50	2.0±0.00	1.85±0.15	2.0±0.00	2.0±0.00	2.5±0.00	2.0±0.00	2.0±0.00	3.0±0.00	2.0±0.00	2.50±0.25	2.0±0.00

RF – Rice flour, MF – Maize flour

investigation.

Water Absorption Capacity (WAC) of both rice and maize flour was found to be 3.91 and 3.27 respectively. The WAC of fresh pinkperch meat was 3.7g water/g of dried material (Rathnakumar, 1999). From the results it was found that WAC decrease with addition of minced meat in all the samples. The ability of the protein molecule to absorb added water, will decrease with alteration of native structure (Hermansson, 1972). Decrease in WAC with addition of minced meat was observed in all the samples. The presence of other non-protein components in the gelatinized product may also influence WAC. The amount of water associated with proteins depends to a larger extent on the amino acid composition, protein conformation (Globular Vs Extended Chain), surface hydrophobicity, pH, salt, temperature, and concentration (Kinsella, 1982). Both linear and quadratic effects of lipid level and moisture affected water-holding capacity (Bhattacharya and Hanna, 1988).

Fat Absorption Capacity (FAC) of extrudates was ranging from 0.61 to 0.68 for rice flour and 0.62 to 0.84 for maize flour. Increase in fat absorption capacity with addition of minced meat was observed in all the samples. FAC increase with addition of minced meat in all the samples and probably due to increase in protein content. FAC is a purely physical phenomenon where entrapment of added oil by macromolecule. It is difficult to give precise reason for increase with addition of minced meat. However it is likely that the alterations in the structure of major protein fraction may have bearing on the FAC value. Water absorption capacity and fat absorption capacity did not significantly ($P>0.05$) vary with quality of the minced meat used at different storage period.

The total plate count of gelatinized products prepared using minced meat with rice flour at 0,5,10,20 and 30% were found to be $1.1x10^3$, $5.5x10^2$, $1.8x10^3$, $1.15 x10^3$ and $2.05 x10^3$ respectively. Similarly, in the gelatinized product prepared using fresh meat with maize flour at 0, 5, 10, 20 and 30% are found to be $0.1 x10^2$, $2.5 x10^2$, $7.0 x10^2$, $6.0 x10^2$ and $0.4 x10^2$ cfu/g respectively. *Salmonella* and *Vibrio* are absent in both products. High internal shear combined with temperature (110°C) may destroy the bacteria. The extrusion processing system has been effective in destroying the organisms commonly used as indictors of food contamination or associated with food

Table 4 ANOVA for Changes in the organoleptic quality of gelatinized product (Fried) using frozen stored minced meat

a) Overall acceptability (Rice flour)

Source of Variation	SS	df	MS	F	5%	1%	L.S
Storage days	4.819615	3	1.606538	10.62812	3.4903	5.952529	*
Treatment	4.53697	4	1.134243	7.50363	3.25916	5.411948	*
Error	1.81391	12	0.151159				
Total	11.1705	19					

b. Overall acceptability (Maize flour)

Source of Variation	SS	df	MS	F	5%	1%	L.S
Storage days	4.819615	3	1.606538	10.62812	3.4903	5.952529	*
Treatment	4.53697	4	1.134243	7.50363	3.25916	5.411948	*
Error	1.81391	12	0.151159				
Total	11.1705	19					

SS- Sum of square; df- Degrees of freedom; MS- Mean sum of square; F- Calculated F value; L.S- Level of significance; N.S. - Not Significant; * - P<0.01; ** - P<0.05.

poisoning (Harper, 1979). They also found that coliforms, *Staphylococcus*, *Salmonella* were destroyed by the extrusion process.

Frozen stored mince was drawn at 30 days interval and mixed with rice flour and maize flour separately to produce gelatinized products. These products were fried in oil and the panel of judges assessed its organoleptic quality every month. The results are presented in Table 3. Overall acceptability of the fried product prepared using rice flour ranged between 4.0 and 5.0 in the first month where as it was 2.5 to 4.5 in the 4th months. Invariably sample with 10% meat ranking between 4.25 to 4.75 in all the four months. Over all quality of fried product from maize flour was between 2.0 and 3.6 in the 1st month and 2.0 and 3.0 at 4th month. From the statistical analyses using analysis of variance (Table 4) it was found that there is a significant difference between the organoleptic parameters and products at 5% and 1% for rice flour based products. However, there is no significant difference (P>0.05) in the organoleptic parameters of gelatinized product prepared using maize flour. But significant difference among the samples prepared at different intervals was observed. The over all acceptability of fried gelatinized products using rice flour and maize flour improved upon addition of minced meat up to 5% and 10% level during first and second month. However, the acceptability declined at 20% and 30% level.

There is significant difference (P<0.01) between organoleptic parameters of the gelatinized products prepared using rice flour, maize flour for different period. From the results it is observed that gelatinized products prepared using frozen minced meat at different duration significantly (P<0.01) differ in their overall acceptability. It is noted that gelatinized product prepared using rice flour with 10% fish meat, rated between good and excellent throughout the study period. No fishy odor was observed. Maga & Reddy (1985) reported that product prepared with corn flour and fish flour using twin screw extruder do not have objectionable fishy odour even after six month of storage. Factors that are accounted for good stability is related with low moisture and fat content of the extrudates (Maga & Reddy, 1985). Products developed in the present investigation also have low moisture, and fat content, from the result it is inferred that maize flour could not be a good base material for the development of fish based gelatinized product because, the overall acceptability invariably ranking between satisfactory and poor.

From the study it is inferred that protein content was found to increase with the addition of minced meat whereas starch content decreases. Addition of minced meat decreases the expansion ratio of the products and at the same time increases its bulk density. Invariably in all the samples water-holding capacity of the product decreases and fat absorption capacity was slightly improved. Organoleptic quality of

the fried gelatinized products prepared using rice flour exhibits good acceptance whereas, products prepared using maize flour did not like very much. Gelatinized product prepared using minced meat, stored at –30°C for 120 days and incorporated at 10% level to the product was found to be acceptable.

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