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Development of Mango Flavoured Instant Porridge Using Extrusion Technology

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Abstract: An instant porridge was developed from twin screw extruder from a combination of wheat grits, mango pulp, sugar and mango flavor. During the standardization, mango pulp was mixed with wheat grits at the rate 100-500 g kg^{-1}. The moisture content of the samples was brought down to 12, 15 or 18% by low temperature drying. The properties of extrudates (expansion ratio and density) and porridge (water absorption index, water solubility index and sensory quality) were studied. Increase in feed moisture content resulted in the decrease in expansion ratio and Water Solubility Index (WSI) and increase in density and Water Absorption Index (WAI) of the extrudates. Increase in pulp level reduced the expansion ratio and WAI and increased the density and WSI. The products were developed with the best selected levels of mango pulp (30%) and feed moisture 15%) with added sugar (15%). Further the porridge was coated with sugar syrup (50°C) along with mango flavor. Porridge stored in LDPE and aluminum laminate pouches at ambient temperature remained acceptable upto 6 months. Mass consumer acceptability scores was found out to be 3.07 out of 4.00.

Key words: Extrusion, breakfast cereals, wheat porridge, water solubility index, water absorption index, expansion ratio

INTRODUCTION

Today's consumer is becoming aware of the concept for convenience and healthy foods. The demand for shelf stable and nutritious convenience foods has been increased due to improving economic status, life style logistics, urbanization and concern about health benefits. Foods are therefore expected to meet the new challenges and technologies needed to be evolved based on available raw material and requirements of the society.

In India, wide ranges of traditional foods are consumed as breakfast. To attract consumers, traditional products must be reformulated to meet demands for fast preparation time, convenience and health significance. Wheat porridge (dalia) is a major breakfast cereal in North India and it is made from cracked wheat by cooking in milk or water and is eaten with salt or sugar added. Acceptability and nutritional attributes are frequently enhanced by added ingredients and sophisticated processing and packaging (Fast, 1987).

Development of products from the combination of cereals with fruits and vegetables is being experimented in number of products. Cereals are good source of carbohydrates and proteins and fruits or vegetables could supplement the vitamins, antioxidants, fiber and phytochemicals in the products. Today, new fruit processing technologies have made it even easier to add these beneficial and tasty ingredients to a wide variety of cereal-based items, from ready to eat cereals to French toast. Call them value added or convenience foods, these fruit and cereal combinations are one of the newest trends in ready to eat breakfast and hot cereals. Extrusion cooking is new processing technology which is being adopted for processing Ready to Eat (RTE) breakfast cereals and many other products. Porridge can be used as good vehicle for supplementation of fruits to add value to improve nutritional composition and enhance appeal. The present study describes the results of the study conducted on development of new instant breakfast cereal product, i.e., wheat porridge incorporating mango fruit by using extrusion technology.

MATERIALS AND METHODS

Raw materials: Samples of wheat (Variety PBW-343) were procured from Department of Plant Breeding and Genetics, PAU, Ludhiana. Mango (Variety Dasheri), ground cane sugar and fruit emulsions (K.K. Industries, Delhi) were procured from the local market. Low density polyethylene (40 μm) and aluminium laminate (polyethylene/aluminium foil/polyethylene-40 μm) were used for packaging of porridge.

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Preparation of blends: Cleaned wheat was milled to grits in a laboratory mill (Model-3303 Perten, Sweden) to pass through 850 μm sieve. Mangoes were peeled. Their stones were separated and the pulp was blended in a mixer. Fruit pulp was mixed with wheat grits at a level of 10, 20, 30, 40 and 50 g/100 g of wheat grits. The samples were dried at 50°C to obtain a final moisture content of 12, 15 and 18%.

Extrusion: The samples were extruded using co-rotating intermeshing twin screw extruder (Clextral BC-21, Firminy, France) having screw diameter 25 mm and L/D ratio 16. Temperatures were maintained at a temperature of 50, 100, 150 and 160°C for first, second, third and fourth zone, respectively. The screw speed was kept constant at 400 rpm. Diameter of the die was 5 mm.

Properties of extrudates and porridge: The extrudates were evaluated for Expansion Ratio (ER), bulk density, Water Absorption Index (WAI), Water Solubility Index (WSI), moisture content and sensory quality.

The expansion ratio was determined by taking the diameter of 10 extrudates with the help of vernier calliper, averaged and divided by the diameter of the die nozzle of the extruder (Rayas-Duarte *et al*., 1998). The bulk density of the extrudates was calculated as per mass per unit volume using the expression:

$$\text{Bulk density (g/cm}^3\text{)} = \text{mass}/\pi r^2 l\ (\text{cm}^3)$$

Water absorption index of the product was determined by method outlined by Anderson *et al*. (1969). The 2.5 g of the ground sample was suspended in 30 mL of distilled water at 30°C in a 50 mL tared centrifuge tube. The contents were stirred intermittently >30 min period and centrifuged at 3000×g for 10 min. The supernatant liquid was poured carefully into tared evaporating dish. The remaining gel was weighed and WAI was calculated as the grams of gel obtained per gram of the solid.

Water Solubility Index was determined from the amount of dried solids recovered by evaporating the supernatant from the water absorption index test described (Anderson *et al*., 1969). It was expressed as a percentage of solid in the sample extract.

Moisture content of porridge was determined by Approved Method 44-19 (AACC, 2000) was followed. The 2 g sample (porridge) was dried in moisture dish at 130±1°C for 1 h, cooled in desiccator and weighed. The moisture loss was expressed in percent.

The 200 mL of hot milk was added to 20 g ground porridge and porridge was served hot. The samples were evaluated for overall acceptability score by semi-trained panel of six judges using a nine point hedonic scale.

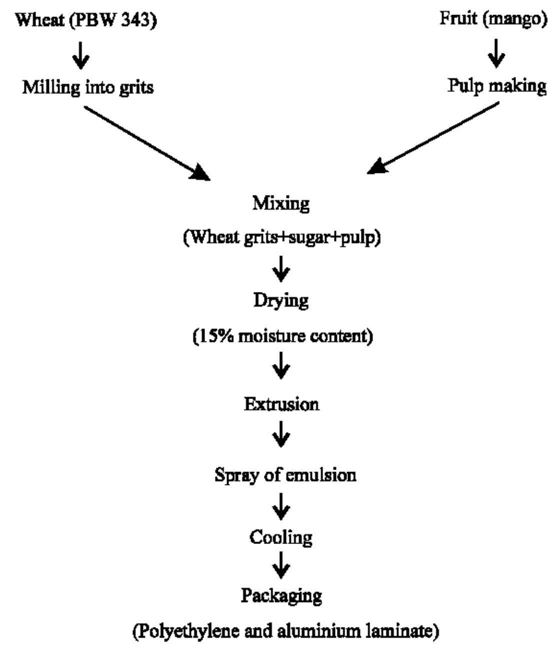

Fig. 1: Flow chart for the preparation of mango incorporated instant porridge from whole wheat

Selection of samples for further study: Based on the results obtained from the above conducted tests, porridge extruded at 15% moisture content with 30, 40% mango pulp were selected for further study. Sugar in different levels (10, 15 and 20%) was incorporated in above selected samples.

Wheat grits, fruit pulp and sugar were mixed together. The samples were kept at 50°C to bring the moisture content to 15%. The samples were extruded using the earlier mentioned conditions using a die with four openings having 1.5 mm diameter of each opening. A two bladed cutter was run at a speed of 15 rpm to obtain porridge. Mango fruit emulsion was sprayed at the exit of die at the rate of 1.0% of the finished product. Flow chart for the preparation of mango incorporated instant wheat porridge is given in Fig. 1.

Sensory quality: The 200 mL of hot milk was mixed with 10-20 g sugar (optional) and 20 g of porridge was added to it, mixed and served hot. Samples with 15% sugar were awarded higher score, so sample No. 2 and 5 were subjected to further analysis.

Chemical characteristics of porridge: Approved methods (AACC, 2000) were followed for estimation of moisture, protein, fat, fibre, sugars, starch and minerals.

Storage studies: Selected porridge samples prepared were packed in two packaging materials namely LDPE and aluminium laminates. Samples were stored under ambient conditions for shelf life estimation by conducting tests for moisture gain at regular intervals of 30 days over a period of 6 months.

Economics: Cost of production was calculated per kg of porridge.

Mass consumer acceptability: Mango porridge was subjected to large scale consumer acceptability trials.

Statistical analysis of data: Data collected was subjected to statistical analysis using analysis of variance technique (Steel and Torrie, 1960).

RESULTS AND DISCUSSION

Results obtained with regard to effect of moisture content and level of mango fruit pulp on physio-chemical characteristics of extrudates; organoleptic quality of instant porridge made from wheat and mango pulp are tabulated and discussed in this study.

Expansion ratio: The expansion ratio and bulk density of extrudates describe the degree of puffing undergone by the material as it exits the extruder. Sectional expansion index considers expansion only in the direction perpendicular to extrudate flow while bulk density considers expansion in all directions (Falcone and Phillips, 1988). Data with respect to the effect of moisture content and level of mango pulp is presented in Table 1.

The measured expansion ratio of wheat grits and mango pulp blend extrudates varied between 2.53 and 3.79. Mean values of expansion ratio shows that the feed moisture content of 12% resulted in higher expansion ratio followed by 15 and 18% moisture content. With increase in mango pulp level, a decreasing trend of expansion ratio is observed. The feed moisture content of 12 and 15% and fruit pulp level of 0-20% resulted into the higher expansion ratio. Mean values showed significant decrease in expansion beyond 15% moisture content. Addition of 30% or more of mango pulp resulted in significantly lower expansion. When extrusion-cooked melts exit the die they suddenly go from high pressure to atmospheric pressure. This pressure drop causes a flash-off of internal moisture and the water vapour pressure which is nucleated to form bubbles in the molten extrudate, allows the expansion of the melt (Arhaliass *et al.*, 2003).

Similar results were reported by Lin *et al.* (2003) in which extrudates, made from rice at 15% moisture content had maximum degree of expansion. Launay and Lisch (1983) reported that for corn extrudate, longitudinal and diametral (sectional) expansions depended on the melt viscosity and elasticity. They reported that an increased moisture content or temperature would yield a lower melt viscosity and increased longitudinal expansion while the melt elasticity would be lowered and a decrease in diametral expansion would be observed. This result is in agreement with other researchers (Dogan and Karwe, 2003; Ilo *et al.*, 1999).

Several researchers have demonstrated that the expansion ratio of extruded cereals depends on the degree of starch gelatinization (Case *et al.*, 1992; Chinnaswamy and Hanna, 1988). Increasing level of mango pulp resulted in decrease in expansion ratio of extrudates. This may be attributed to dilution effect of fruit pulp on starch and the high fibre content which competes for the free water found in the matrix, lowering its expansion capabilities. Similar finding of lowering expansion ratio of extruded biscuits by incorporation of extruded orange pulp containing higher fiber was reported Larrea *et al.* (2005).

Table 1: Effect of feed moisture content and level of mango pulp on expansion ratio of wheat extrudates

	Level of mango pulp (%)						
Moisture (%)	0	10	20	30	40	50	Mean
12	3.79	3.74	3.52	3.25	3.04	2.99	3.39
15	3.67	3.62	3.31	3.16	3.35	2.99	3.35
18	3.16	3.03	2.87	2.85	2.79	2.53	2.87
Mean	3.54	3.46	3.23	3.09	3.06	2.84	3.20

LSD = 0.36

Table 2: Effect of feed moisture content and level of mango pulp on density (g/cc) of wheat extrudates

	Level of mango pulp (%)						
Moisture (%)	0	10	20	30	40	50	Mean
12	0.12	0.15	0.17	0.19	0.18	0.20	0.17
15	0.13	0.13	0.17	0.19	0.24	0.24	0.18
18	0.19	0.21	0.22	0.25	0.36	0.39	0.27
Mean	0.15	0.16	0.19	0.21	0.26	0.28	0.21

LSD = 0.06

Bulk density: Bulk density has been linked with the expansion ratio in describing the degree of puffing in extrudates (Asare *et al.*, 2004). Data with respect to the effect of moisture content and level of mango fruit pulp is presented in Table 2. Density which considers expansion in all directions, ranged from 0.12-0.39. The mean value for densities showed that feed moisture content of 18% resulted in significantly higher density and there was a non significant difference among 12 and 15% content. Increase in the level of fruit pulp showed an increasing trend of density. Compared with the control, the level of mango fruit pulp had a significant effect on the mean values for density beyond 20%. The highest density was recorded at 50% incorporation of fruit pulp at 18% feed moisture content.

A high bulk density is associated with a low expansion index (Rayas-Duarte *et al*., 1998; Suknark *et al*., 1997). Samples extruded at 15% feed moisture content indicated a comparatively low density and high expansion ratio. At low feed moisture content, heat energy directly increases the product temperature. As the product temperature increase, the materials are more fully cooked and become more plastic. This condition and high flashing moisture in the die caused the product to expand more, reduced its bulk density and product moisture content (Kohda *et al*., 1989). Similar results were reported which states that increased feed moisture leads to a sharp increase in extrudate density (Ding *et al*., 2006). High feed moisture resulted in a rubbery texture with relatively high density.

Increase in bulk density with increase in level of fruit pulp may be due to increasing fibre content of feed material. This was because the presence of fibre particles tended to rupture the cell walls before the gas bubbles had expanded to their full potential (Lue *et al*., 1991). Similar effect of fiber has been observed for extrusion of yellow corn with wheat and oat fiber, corn meal and sugar beet fiber, corn meal with soy fiber, salt and sugar, jatoba flour and cassava starch blends and corn starch with pectin and wheat fiber (Hsieh *et al*., 1989; Lue *et al*., 1991; Jin *et al*., 1994; Chang *et al*., 1998; Yanniotis *et al*., 2007). Sugar could be another reason for increase in bulk density with higher pulp content. Sugar would limit the availability of water might also hinder gelatinization of starch which could be another factor. However, the actual mechanism has more to do with the plasticization effect of sugar leading to lower melt temperatures and thus reduced vapour pressure of water (Altan *et al*., 2008a, b). Similarly, lowest bulk density value was reported by Altan *et al*. (2008a, b) at higher temperatures with a low level of tomato pomace.

Water Absorption Index (WAI): Water absorption has been generally attributed to the dispersion of starch in excess water and the dispersion is increased by the degree of starch damaged due to gelatinization and extrusion-induced fragmentation that is molecular weight reduction of amylase and amylopectin molecules (Rayas-Duarte *et al*., 1998). The values of WAI ranged between 4.82-6.48 g g^{-1} (Table 3).

As the moisture content increased from 12-18%, the mean values for water absorption index showed an increasing trend. The water absorption index tended to be higher with higher starch content. Increase in level of mango pulp showed a decreasing trend of water absorption index.

Table 3: Effect of feed moisture content and level of mango pulp on Water Absorption Index (WAI) (% db) of wheat porridge

	Level of mango pulp (%)						
Moisture (%)	0	10	20	30	40	50	Mean
12	5.01	5.00	4.98	5.00	4.94	4.82	4.96
15	6.35	5.91	5.99	5.69	5.62	5.47	5.84
18	6.48	6.47	5.91	5.81	5.65	5.75	6.01
Mean	5.95	5.79	5.63	5.50	5.40	5.35	5.60

LSD = 0.36

WAI is a gelatinization index and it is generally agreed that feed moisture and barrel temperature exert greatest effect on the extrudate by promoting gelatinization (Ding *et al*., 2005). At high moisture content, the viscosity of the starch would be low, allowing for extensive internal mixing and uniform heating which would account for enhanced starch gelatinization (Lawton *et al*., 1972) which may lead to increased water absorption. Similar effects of increasing moisture content on WAI have been reported earlier for rice based extrudates (Ding *et al*., 2005) and extrusion of rice with pea grit (Singh *et al*., 2007). WAI decreased considerably as the percentage of fruit pulp increased. This may be attributed to relative decrease in starch content with addition of pulp and competition of absorption of water between pulp and available starch. This result is in agreement with those of Artz *et al*. (1990). They reported a decrease in water holding capacity when the ratio of fiber/corn starch increased in extrusion of corn fiber and corn starch blend. Singh *et al*. (2007) observed a decrease in WAI with addition of pea grits in extrusion of rice. They explained that a decrease in WAI was due to the dilution of starch in rice pea blends. The amount of water absorbed by the ground extrudate has been used to as indirect estimation of the porosity of the material (Collona *et al*., 1989). As the expansion ratio of the extrudate material increases, the water absorption would also increase (Rayas-Duarte *et al*., 1998). These relationships are not surprisingly since, the product is more porous it can hold more water.

Water Solubility Index (WSI): Water solubility index, often used as an indicator of degradation of molecular components (Kirby *et al*., 1988), measures the degree of starch conversion during extrusion which is the amount of soluble polysaccharide released from the starch component after extrusion (Ding *et al*., 2005). The values for water solubility index are presented in Table 4. Mean value of water solubility index showed that the feed moisture content had significant effect on the WSI with 12% resulted into highest water solubility index followed by 15 and 18% moisture content. Similar effects have been reported in literature for rice-based extrudates (Ding *et al*., 2005) and maize-finger extrudates (Onyango *et al*., 2004).

Table 4: Effect of feed moisture content and level of mango pulp on Water Solubility Index (WSI) (% db) of wheat porridge

	Level of mango pulp (%)						
Moisture (%)	0	10	20	30	40	50	Mean
12	21.92	22.24	21.86	22.25	22.34	22.14	22.13
15	19.05	20.94	20.68	21.02	21.52	21.66	20.81
18	18.41	18.24	18.92	18.16	19.74	19.68	18.86
Mean	19.79	20.47	20.49	20.48	21.20	21.16	20.60

LSD = 1.26

Table 5: Effect of feed moisture content and level of mango pulp on final moisture content (%) of wheat porridge

	Level of mango pulp (%)						
Moisture (%)	0	10	20	30	40	50	Mean
12	5.20	5.09	5.35	5.29	5.17	5.47	5.26
15	6.05	6.47	5.92	5.96	5.75	7.59	6.29
18	6.98	7.95	6.53	6.42	6.95	8.13	7.16
Mean	6.08	6.50	5.93	5.89	5.96	7.06	6.24

LSD = 0.40

It was suggested that increasing WSI is caused by greater shear degradation of starch during extrusion at low moisture conditions. Jean *et al.* (1996) reported that extrudates at low feed moisture content have higher compressive resistance and cause solubility changes in the starch.

The solubility increase in extrudates means the starch granule increases the fragmentation ratio at low feed moisture during extrusion of corn meal (Gomez and Aguilera, 1983; Wen *et al.*, 1990).

Increase in level of mango pulp showed an increasing trend of water solubility index and compared to control a significant increase was observed beyond 30% mango pulp. Higher values for water solubility index were recorded at feed moisture content of 12% and level of mango pulp 40-50%. WSI increased as a function of pulp content. WSI is a parameter that reflects the degradation suffered by the components of the fiber (Larrea *et al.*, 2005). The increased WSI found in extruded products can be related to the lower molecular weight components which can be separated quite easily from each other when the processing conditions are more severe (Collona *et al.*, 1989). Fruit pulp is relatively high in fiber content. Above critical concentration, the fiber molecules disrupt continues structure of the melt in extruder, impeding elastic deformation during extrusion (Moraru and Kokini, 2003). So, the greater WSI values may be due to disintegration of starch granules and lower molecular compounds from extrudate melt during extrusion process this may cause in an increase in soluble material.

Moisture content: Statistically significant variations were observed for moisture content of mango incorporated wheat porridge among different feed moisture contents and mango pulp levels (Table 5). The final moisture content of the mango incorporated porridge ranged from 5.09-8.13. The mean value for moisture content increased with increase in feed moisture content. Different fruit pulp levels showed no trend. The highest value for moisture content was observed at 18% feed moisture. High feed moisture resulted in a rubbery texture with relatively high bulk density which is why he expanded shape of the product was not maintained after extrusion (Della Valle *et al.*, 1987).

Table 6: Effect of feed moisture content and level of mango pulp on sensory quality (score out of 9) of wheat porridge

	Level of mango pulp (%)						
Moisture (%)	0	10	20	30	40	50	Mean
12	6.08	6.35	6.67	7.69	7.56	7.03	6.89
15	7.10	7.36	7.37	8.01	7.85	7.51	7.53
18	6.66	6.51	6.59	7.26	7.23	6.83	6.85
Mean	6.61	6.74	6.88	7.65	7.55	7.12	7.09

LSD = 0.29

Table 7: Effect of sugar level on sensory quality (score out of nine) of mango incorporated

	Level of fruit pulp (%)			
		Mango		
Sugar level (%)	Control	30	40	Mean
10	6.43	7.21	6.77	6.68
15	6.68	8.00	8.04	7.36
20	7.24	8.09	8.12	7.47
Mean	6.78	7.77	7.64	7.17

LSD = 0.28

Overall acceptability (score out of 9): The data with respect to overall acceptability of mango pulp incorporated wheat porridge is given in Table 6. The mean scores of sensory evaluation showed that all products with mango pulp were within the acceptable range. A statistically significant difference was observed for mean values of overall acceptability.

The overall acceptability scores and mass consumer acceptability for wheat porridge incorporating mango pulp was maximum when the grits were extruded at 15% moisture content for the mango pulp level 30%. Significantly lower mean value was recorded for fruit pulp level 10 and 50% as compared 20-40% because of lower expansion. If the product expands less, a compact structure appears to be dull and hence it results in low score in sensory.

Effect of sugar level on sensory quality (score out of nine): Data with respect to the effect of sugar level on sensory quality of mango incorporated porridge is given in Table 7. It was observed that with increase in sugar level, sensory scores increased for each level of fruit

Table 8: Chemical composition of selected levels of fruit incorporated porridge

Samples	Protein (%)	Fat (%)	Crude fibre (%)	Reducing sugars (glucose %)	Non-reducing sugars (glucose %)	Starch (%)
Control	10.15	1.47	1.57	8.41	11.50	58.67
Mango 30%	9.81	1.08	2.14	9.28	12.09	57.06
Mango 40%	9.49	0.94	2.42	10.43	13.10	54.66
LSD	0.31	0.21	0.27	0.39	0.31	2.19

incorporated porridge. A noticeable increase in the appearance of porridge was observed with increasing levels of sugar substitution.

Significant variations in the organoleptic scores were observed when sugar was incorporated in selected samples of porridge at different levels. The overall acceptability of the 40% mango pulp incorporated sample was highest followed by the 30% mango pulp in which 30% sugar was incorporated. Correlating the good overall acceptability scores with the good appearance, texture and good flavour, porridge formulation with 30% sugar incorporation was suggested.

Chemical characteristics of porridge: The data with respect to chemical characteristics of porridge is tabulated in Table 8. The protein content ranged from 9.28-10.15%. The fat content in the mango incorporated samples was normally low between 0.83-1.09% and the porridge made from wheat variety (PBW 343) had fat percentage of 1.47%. The crude fiber content of the fruit incorporated samples varied from 2.14-2.63%. Fiber is mostly present in small amounts (<9%) except in the high fiber breakfast cereals like oat cereal and cereals in which bran is incorporated. The fiber content of product made without mango fruit was found to be 1.57. The relationship between starch and sugar contents was observed. Generally an increase in the content of one proportionately decreased the content of the other. The values for reducing sugars ranged from 7.76-10.43 and for non-reducing sugars the range was 11.50-13.10. The starch content varied from 54.66-58.67%. The chemical composition of thirty six breakfast cereals purchased from different manufacturers and the results reported are in agreement with the present study (Jones *et al*., 2000).

Mineral composition: Significant difference was observed between mean values of different elements present in porridge (Table 9). Increase in values of sodium, iron and zinc was observed. Decrease in values of other elements may be due to dilution of wheat with fruit pulp.

Storage of mango incorporated porridge: Significant variations were observed in the moisture content of mango incorporated porridge packed in Low Density Polyethylene (LDPE) and Aluminum Laminates during storage under ambient conditions (Fig. 2). The moisture content with respect to the formulations, packaging material and the days of storage showed a significant variation (Table 10). Porridge with 40% mango had higher initial moisture content than the 30% mango pulp incorporated porridge packed in polyethylene. Moisture gain by biscuits in different packaging material has been reported by Zabik *et al.* (1979) and Sathe and Salunkhe (1981). Singh *et al.* (2000) also reported that the moisture

Table 9: Mineral composition (mg/100 g) of selected levels of fruit incorporated porridge

Elements	Wheat grains	Level of mango pulp: Mango 30%	Mango 40%	LSD (0.05)
Calcium	40.60	38.50	37.40	3.1
Potassium	250.00	270.00	281.00	13.2
Magnesium	64.90	61.00	60.40	3.7
Sodium	270.00	1011.00	1111.00	27.0
Phosphorus	208.00	207.00	194.00	13.6
Copper	0.35	0.29	0.33	0.2
Iron	3.20	3.40	3.80	0.5
Manganese	3.00	1.60	1.60	0.3
Zinc	3.90	4.30	4.80	0.5

Table 10: Effect of packaging material and storage period on moisture content (%) of mango porridge

Storage period (months)	Control P	Control L	Mango 30% P	Mango 30% L	Mango 40% P	Mango 40% L
0	7.01	7.01	6.70	6.70	7.12	7.12
1	7.12	7.18	6.89	6.67	7.69	7.28
2	7.16	7.49	7.64	6.82	8.01	7.76
3	7.44	7.50	7.99	7.04	8.38	8.26
4	7.87	7.70	8.09	7.85	8.70	8.54
5	8.02	7.99	8.23	7.99	8.67	8.60
6	8.35	8.20	8.30	8.07	8.81	8.74

P: Low density polyethylene; L: Aluminium laminate

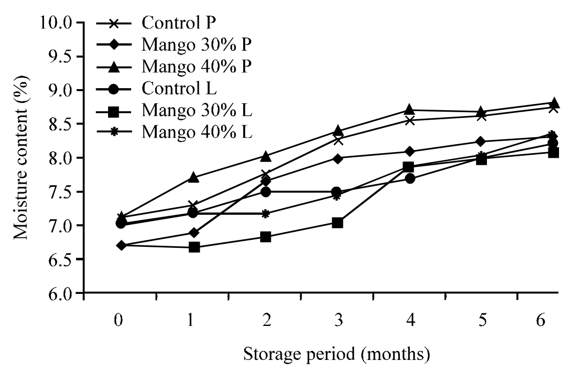

Fig. 2: Effect of storage on moisture content (%) of mango porridge

contents of samples increased with the time of storage. Gupta and Singh (2005) reported that moisture content in different categories of biscuits increased after 60 days of storage at room temperature.

Economics-cost of final product: The cost effectivity of the 30% mango pulp and sugar incorporated porridge made from wheat for the study was calculated:

Cost price of wheat	=	Rs. 15/kg
Cost price of 300 g mango pulp	=	Rs. 21
Cost price of 300 g sugar	=	Rs. 10.50
Cost price of 10 mL emulsion	=	Rs. 1.0
Processing expenses	=	Rs. 16/kg

Cleaning, milling, drying and extrusion:

Packaging cost	=	Rs. 15/kg
Total cost of the final product	=	Rs. 78.50/kg

CONCLUSION

It is evident that highly acceptable instant fruit porridge capable of reconstitution in 4-5 min by putting in boiling milk can be prepared by using extrusion processing that could add variety to the traditional products. A feed moisture content of 15% and mango pulp level of 30 with 30% of sugar was found to be most acceptable. Fruit porridge could be stored for 180 days in LDPE under ambient conditions. The estimated cost for instant mango porridge found out to be Rs. 78.50/kg. Average mass consumer acceptability score was 3.07 out of 4.00.

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