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Storage stability studies of corn based rice bran incorporated extruded snacks

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Abstract
Keeping in view of the consumer's awareness towards the quality and safety of food products, shelf life studies play an important role. Storage studies are carried out to analyze the quality characteristics and product behavior during storage. A study was conducted in the Division of Food Science and Technology, SKUAST- K, Shalimar to investigate the effect of storage on quality characteristics of corn based rice bran incorporated extruded snacks extruded at pre optimized conditions (10% rice bran incorporation, moisture content of 14%, barrel temperature of 135 ^{0}C and screw speed of 300 rpm. These snacks were then stored in high density polyethylene (HDPE) for four months at ambient temperature and evaluated for moisture content, water activity, free fatty acids, breaking strength, total plate count and overall acceptability at an interval of 30 days for a period of four months.

Keywords: corn, rice bran, extrusion, storage

1. Introduction
Extrusion cooking is a low-cost and efficient technology that utilizes high temperature, pressure and shear force to produce highly expanded, low-density snacks with unique textural properties. The thermo mechanical action during extrusion brings about gelatinization of starch, denaturation of protein and inactivation of enzymes, microbes and many anti-nutritional factors; all this occurs in a shear environment, resulting in a plasticized continuous mass (Bhattacharya and Prakash, 1994) [5]. The snack foods industry is a vibrant sector and future for the industry looks promising and bright. Breakfast snacks have became an integral part of daily diet in majority of the countries and are gaining momentum due to busy schedule of people and need for convenience food. Extrusion cooking, a versatile food processing technique being the high temperature short time process has become the method of choice for the development of snacks owing to nutrient retention and favorable economics of the process (Onyango *et al*. 2004) [13]. Cereals are the main raw materials used for the development of extruded snacks (Pradeep *et al*. 2013) [14]. Breakfast snacks have became an integral part of daily diet in majority of the countries and are gaining momentum due to busy schedule of people and need for convenience food. Corn flour because of its superior characteristics is one of the major ingredient for extrusion owing to its starch content, flavor and attractive yellow color. Incorporation of fibers has shown to cause positive impact on the nutritional value of snacks. Rice bran on an average contains 25.50% of dietary and thus can be effectively incorporated into corn flour for the development of a healthy and fiber rich snack.

2. Material and Methods
2.1 Preparation of raw material
The present investigation was carried out in the Division of Post Harvest Technology, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir (SKUAST-Kashmir), Shalimar, Kashmir. Corn (C-6) variety obtained from division of plant breeding and genetics, SKUAST-K was milled in lab mill 3030 (Perten, Sweden) to fineness that passes through 200mm sieve. The Jhelum variety of rice was procured from Mountain research center for field crops (MRCFC), Khodwani Anantnag. Milling of paddy was done at the Division of Food Science and Technology, SKUAST-K and the bran was stored at ambient temperature in polyethylene bags for further use.
The blends of corn flour and rice bran were extruded at pre-optimized conditions i,e 10% apple powder, 14% moisture, 135 ^{0}C barrel temperature and screw speed of 350 rpm and were stored in HDPE for four months. Extruded snacks were studied at an interval of 30 days for moisture content, water activity, free fatty acids, breaking strength, total plate count and sensory quality. Moisture content was determined as per AOAC 1995 method [3]. Water activity was measured using water activity meter (AQUA LAB, SN: PRE-000197).

Breaking strength was determined using Texture analyser. Standard AOAC procedure was followed with slight modification for free fatty acid determination. Sensory evaluation of snacks was done by a panel of semi- trained judges using 5- point scale. Total plate count was carried by standard serial dilution plate count method using nutrient agar (Anonymous, 1957) [2], Martin's lose Bengal agar (Martin and James, 1995) [12].

2.2 Extrusion cooking

The extrusion was performed on co-rotating intermeshing twin screw extruder model BC 21 (Clextral, Firminy, France). The barrel diameter and its length to diameter ratio (L/D) were 2.5 mm and 16:1, respectively. The extruder had four barrel zones, temperature of the 1st, 2nd, and 3rd was maintained at 20, 30 and 40℃, respectively, throughout the study period; while the temperature in last zone (compression and die section) was varied according to experimental design. The extruder was equipped with torque indicator which showed percent of torque in proportion the current drawn by drive motor. Raw material was metered into extruder with a single screw volumetric feeder. A cutter with bladed knives and a die made of stainless steel were used for shaping the extrudates.

2.3 Quality parameters

Physico-chemical characteristics i.e. Moisture was studied using AOAC 2000 methods. Water activity was estimated using water activity meter (Rotronic, UK). Standard AOAC procedure was followed with slight modification for free fatty acid determination. Break strength was estimated using Texture analyzer and total plate count was studied by standard serial dilution plate count method using nutrient agar (Gaosong *et al*. 2000) [10], Martin's lose Bengal agar (Al-Farsi *et al*. 2007) [1]. Extruded snacks were studied for the period of four months at regular intervals.

2.4 Sensory analysis

Sensory quality of extrudates sample was determined with the help of 10 semi trained panelist using a 5-point Hedonic scale (5-excellent to 1-poor). The aspects considered were color, appearance, texture, flavor, mouth feel and overall acceptability. Overall acceptability was evaluated as an average of color, appearance, texture, flavor and mouth feel. The average scores of all the 10 panelists were computed for different characteristics.

Table 1: Effect of storage period on moisture content, water activity, free fatty acids, breaking strength, total plate count and overall acceptability

Storage period (Days)	Moisture content (%)	Water activity	Free fatty acids (%)	Breaking strength (N)	Total plate count (CFU/g)	Overall acceptability
0	4.00	0.20	0.18	27.89	0	4.25
30	4.27	0.28	0.28	26.30	0	4.15
60	4.85	0.32	0.33	25.25	TFTC	4.10
90	5.32	0.37	0.38	22.00	TFTC	3.43
120	5.75	0.40	0.41	19.00	TFTC	3.06
CD($p \leq 0.05$)	0.04	0.04	0.03	0.04	NS	0.04

TFTC = Too few to count, NS = Non significant

3. Results and Discussion

3.1 Storage stability of snacks

The blends of corn and rice bran extrudates, extruded at optimized conditions were packed in HDPE bags, stored for 4 months at ambient temperature and were analyzed at an interval of 30 days for the moisture content, water activity, free fatty acids, breaking strength, total plate count and sensory evaluation.

3.2 Moisture content

The perusal of data obtained from Table 1, indicated that with the advancement of storage period, an increase in moisture content was observed in extruded snacks. The moisture content of the product ranged from 4 to 5.75% at 120th day of storage. Effect of storage period was found to be significant on the moisture content of the snacks. This increase in moisture was due to hygroscopic nature if extrudates (Butt *et al*. 2004) [7]. Charunuch *et al*. (2008) [8] also reported an increase in moisture content in Thai rice extruded snack supplemented with mulberry during storage of 4 months.

3.3 Water activity

Water activity is an indicator of quality and stability of extruded food products. The water activity of extruded products increased during storage from 0.20 to 0.40. The increase in water activity of extrudates might be attributed to the humid environmental conditions. These results are in alignment with those of Hussain *et al*. (2015) [16].

3.4 Free fatty acids

Storage had significant effect on the development of FFA over the period of four months. With the advancement of storage the FFA of the extrudates increased significantly however this increase was in safe limits for human consumption. The FFA content increased from 0.18 to 0.41% (Table 1) in four months. This increase in FFA during storage might be due the lipolytic activity of enzyme lipase which further increased because of the favourable conditions during the storage at ambient conditions. to the cleavage of long fatty acid chain into individual fatty acid moieties and increased lipid hydrolysis at elevated temperature (Khan *et al*. 2011) [11]. Similar results were also reported by (Bindu *et al*. 2007; Aubourg *et al*. 1997) [6, 4].

3.5 Breaking strength

The perusal of data from Table 1, showed a decreased hardness during a storage period of four months. The hardness of the product decreased from 27.89 to 19 N. the breaking strength or hardness has a inverse relation with the moisture. As the product absorbs moisture during storage it becomes softer and hence lesser amount of force is required to break it therefore the decrease in hardness might be related to gain in moisture of extrudates and thereby increased starch bonding (Dar *et al*., 2014) [9]. Our results are in agreement with (Hussain *et al*. 2015) [16].

3.5 Total plate count
The microbiological change as measured by TPC in the extruded snacks stored at ambient temperature condition was within permissible limits. This indicates the extrudates were microbiologically safe during the storage period. Similar findings were reported by (Hussain *et al*. 2015) [16].

3.6 Overall acceptability
The extrudates were organoleptic evaluation every month during storage period of four months. Overall acceptability score showed a slight decrease during the storage period of 120 days. The evaluated organoleptic parameters were within acceptable range during storage period of four months. Pradeep *et al*. (2013) [14] reported that overall acceptability of RTE nutritious snacks packed in HDPE was with the acceptable range over the period of 90 days. Overall acceptability of rice based snake was with the accepted range over the 90 days of storage (Sharma 2012) [15].

4. Conclusion
Storage studies revealed that corn flour: rice bran extruded products showed no significant changes in quality and overall acceptability during four months of storage. All the quality parameters were within acceptable limits. There was a slight decrease in acceptability owing to the texture degradation due to moisture absorption by extrudates. It can be concluded that corn based rice bran incorporated extruded products are fit for consumption when stored in High density polyethylene (HDPE) for four months of storage.

5. References

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