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Preparation and Storage Studies of Walnut Kernel Incorporated Rice Based Snacks

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Abstract—*The paddy variety Jehlum procured from Mountain Research station for field crops, SKUAST Kashmir was shelled using Satake rice mill to obtain brown rice, which in turn was passed through rice polisher. The small rice brokens and broken walnut kernels (procured locally) were ground in a lab mill model 3303 (perten, Sweden) to a fineness that passes through 200µm sieve. Extrusion experiment was performed in a co-rotating Intermeshing twin screw exrtruder (Clextral BC-21 Firminy France). The Storage behaviour of rice based snacks extruded at pre-optimised conditions (10% walnut kernel incorporation, 14% moisture content, 550 rpm screw speed and 170^{0}C barrel temperature) was studied in the present investigation. The optimised extruded snacks were packed in low density polyethylene bags and kept under ambient conditions for a period of three months and were analysed at an interval of one month for moisture content, water activity, free fatty acids, hardness, total plate count and sensory evaluation. Gradual increase in moisture content, free fatty acid and a gradual decrease in hardness and overall acceptability was observed during three months of storage. However no recordable change was observed in total plate count. There was very small change in moisture content, water activity, free fatty acid content, hardness and overall acceptability of snacks. It can be therefore concluded that walnut kernel incorporated rice based extruded snacks could be stored in LDPE bags for three months under ambient conditions.*

Keywords*: Rice broken, Walnut kernel, Extrusion, Optimization, Response surface Methodology.*

1. INTRODUCTION

Snack foods, which act as a hunger quencher, is something away from main meal and have become an integral part of the daily food intake of the majority of the world's population. Due to processing flexibility offered by extrusion cooking technology, it has become a cornerstone in the food industry, primarily in the cereal, dairy, bakery, confectionary and pet food industries [12]. Broken rice-a byproduct of rice milling process has nutritive value similar to whole rice and is readily available at relatively cheaper rates. It could therefore become an attractive ingredient in extrusion industry. In general, extrusion processing of starch based food materials has been very well studied and well commercialized especially in the category of breakfast cereals [8, 10]. However, high fat extruded breakfast snacks are not available in the market; hence there is an increasing interest in enhancing the fat component of such products.

Walnut kernel on an average contains 60-70 per cent lipids comprising of mono and poly unsaturated fats, 15.2 per cent proteins, 13.7 per cent carbohydrates, 6.7 per cent dietary fibre and 1.8 per cent ash [6, 7]. Walnut kernels could be therefore used for the production of energetic and nutritious extruded snacks.

2. MATERIAL AND METHODS

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 in collaboration of department of food science and technology, PAU, Ludhaina. Paddy variety Jhelum procured from Mountain Research Centre for field crops, (Khudwani, Anantnag) was milled (model 3303, perten sewden) in the Division of Post Harvest Technology, SKUAST-Kashmir. The small rice brokens (<1/8th of actual kernel size) and walnut kernels (procured locally) were ground in grinder (Black and FG-550) to form powder/flour and sieved. The blends of rice and walnut kernel flour were extruded at pre-optimized conditions i,e 10% walnut kernel, 14% moisture, 550 rpm screw speed and 170^{0}C barrel temperature and were stored in LDPE for three months. Extruded snacks were studied at an interval of one month for moisture content, water activity, free fatty acids, hardness, total plate count and sensory evaluation.

Moisture, protein, fat ash and fiber were studied using AOAC 2000 methods. Carbohydrate estimation was done by difference method whereas energy in kcal/100g was estimated by Bomb Calorimeter Model 6050 (Parr instruments, USA). Water activity was estimated using water activity meter (Rotronic, UK). Standard AOAC procedure was followed with slight modification for free fatty acid determination. Hardness was estimated using Texture analyser and water activity was estimated using water activity meter (Rotronin UK) . Total plate count was studied by standard serial dilution plate count method using nutrient agar [1], Martin's lose Bengal agar [11]. Sensory evaluation of snacks was done by a panel of semi-trained judges using 5- point scale.

3. EXTRUSION COOKING

*The extrusion experiment was performed*in a co-rotating intermeshing twin screw extruder (Clextral BC-21, Firminy, France) at Department of Food Science and Technology, PAU, Ludhiana. The barrel diameter and its length to breadth ratio (l/b) were 2.5 mm and 16:1 respectively. The extruder barrel is divided into four zones. Temperature of first, second and third zone was maintained at 30, 60 and 90^{o}C respectively, throughout the experiment, while the temperature at the fourth zone was varied to the experimental design. The extruder was equipped with a torque indicator, which showed per cent of torque in proportion to be current drawn by the drive motor. Blended materials were then metered into the extruder with a single screw volumetric feeder (DS and M, Modena Italy). The feed rate was varied for the optimum filling of the extruder barrel corresponding to screw speed. The moisture content of the feed was adjusted by injecting water (approximately 30^{o}C) into the extruder with a pump. A variable speed die face cutter with four blade knives was used to cut the extrudates.

4. RESULT AND DISCUSSION

4.1 Proximate analysis of raw materials

The data given in the Table 1 depicts the chemical composition of broken rice and walnut kernels. Rice contains 11.92 per cent moisture, 8.09 per cent protein, 0.23 per cent fat, 0.47 per cent ash, 0.78 per cent fibre, 78.51 per cent carbohydrate content and provides 348 kilo calories of energy per 100 gram. Walnut kernel on the other hand contains 2.05 per cent moisture, 65 per cent fat, 15.2 per cent protein, 6.7 per cent fibre, 1.8 per cent ash, 9.25 per cent carbohydrate and provides 682 kilo calories of energy per 100 gram.

Table 1: Proximate Composition of Rice and Walnut Kernel

Parameters	Rice	Walnut kernel
Moisture (%)	11.92	2.05
Protein (%)	8.09	15.2
Fat (%)	0.23	65
Ash (%)	0.47	1.8
Fibre (%)	0.78	6.7
Carbohydrates (%)	78.51	9.25
Energy (Kcal/100g)	348	682

4.2 Proximate composition of final product

Table-2 shows the proximate composition of final snacks obtained by the pre- optimized processing conditions. Final product has low fat as compared to walnut kernel and high protein as compared to broken rice flour. The carbohydrate content of final snack was high as compared to broken rice flour and walnut kernel.

Table 2: Proximate Composition of Final Extruded Snacks

Moisture (%)	3.42
Protein (%)	9.5
Fat (%)	3.3
Ash (%)	0.60
Fibre (%)	2.8
Carbohydrate (%)	80.38
Calorific value (Kcal/100g)	389.22
Hardness (N)	50

5. STORAGE STABILITY OF SNACKS

The optimized extruded product was packed in low density polyethylene (LDPE) bags, kept for 3 months at ambient temperature and were analysed at an interval of one month for the different quality attributes.

5.1 Moisture content

Storage had a significant effect on moisture content. Gradual increase in moisture content (%) was observed during 3 months of storage. The mean moisture content of final snack increased from 3.42 to 4.75 per cent during 3 months of storage (Table 3). The increase in moisture content during storage was due to the hygroscopic nature of the product. During storage the products absorb the moisture from the environment. Sharma *et al*. (2004) reported that moisture gain during storage is due to the hygroscopic properties. Butt *et al*. (2009) stated that the increase in moisture content of flour during storage period of 45 days was due to relative humidity and hygroscopic properties of flour.

6. FREE FATTY ACIDS

The mean value of free fatty acids at the zero months was 0.139 per cent and the mean value after 3 months was 0.189% (Table 3). During storage the free fatty acids showed a gradual increase. However the increase was in safe limits. The increase in free fatty acids may be attributed to the presence of lipolytic activity of enzyme lipase, which might have increased under favourable conditions during storage. The increase in free fatty acids during storage might be due to the breakage of long fatty acid chain into individual fatty acid moieties and also increased lipid hydrolysis at elevated temperature [9]. Khan *et al*. (2011) also reported that the free fatty acids increased from 0.46 to 1.79 per cent as oleic acid in bran enriched chapattis during 12 months of storage. Similar results were also reported by Bindu *et al.* (2007) and Aubourg *et al*. (1997). Sharma *et al*. (2011) reported that the free fatty acid content of cereal barns increased during storage.

7. HARDNESS

Storage had a significant effect on hardness of extrudate. The hardness decreased from the mean value of 52N to 40N during 3 months of storage (Table 3). The hardness shows the inverse relation with moisture. With the storage the extrudates absorbs more moisture which results in less force requirement to break the product. Charunuch *et al*. (2008) reported that during 4 month of storage there was decrease in hardness from 21.38 to 19.44N for thia rice snacks.

8. WATER ACTIVITY

The mean water activity value of extrudates at zero month was 0.40, which was increased to 0.56 after three months of storage. In general not much variation was observed in water activity of extrudates during the three months of storage. The slight increase in water activity during storage was possibly due to change in humidity conditions of the surroundings.

9. TOTAL PLATE COUNT

With the storage not much difference in total plate count was observed. No significant growth of microbes was observed. The total plate count was too few to count (TFTC < 25 colonies/plate) upto 3 months of storage.

10. OVERALL ACCEPTABILITY

Storage period slightly affected the acceptability of snacks. The reduction in overall acceptability of snacks was found up to 3 months of storage. Changes in texture/appearance of snacks were particularly noticed on storage, while mouth feel and flavour score were not much varied during storage studies. The overall score decreased from 4.8 to 4.00 on a 5 point scale.

Table 3: Effect of Storage Period on Moisture, Free Fatty Acids, Hardness, Total Plate Count and Overall Acceptability Snacks

Storage period	Moisture content (%)	Water activity	Free fatty acids (%)	Hardness (Newton)	Total plate count CFU/g	Acceptability
0	3.42	0.40	0.139	52	--	4.8
1	3.74	0.44	0.163	46	--	4.5
2	4.25	0.49	0.171	42	TFTC	4.2
3	4.75	0.56	0.189	40	TFTC	4.00
Mean	4.04	0.47	0.165	45	--	4.37

TFTC = Too few to count

11. CONCLUSION

Based on physic-chemical and sensory evaluation, it can be concluded that no significant changes were observed in rice-walnut kernel blended extrudates after 3 months o storage under ambient conditions. The product was well accepted after 3 months. However the product is rich in fat content, therefore there is need to conduct further studies on shelf life of products after 3 months of storage under ambient conditions.

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