www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(8): 1549-1552

www.thepharmajournal.com
Received: 13-05-2022
Accepted: 21-07-2022

**Tabeen Jan**
Research Scholar, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Jammu and Kashmir, India

**Syed Zameer Hussain**
Professor and Head, Division of Food Science and Technology Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Jammu and Kashmir, India

**Saadiya**
Research Scholar, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Jammu and Kashmir, India

**Aasima Rafiq**
Assistant Professor, Division of Food Science and Technology Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Jammu and Kashmir, India

**Corresponding Author:**
**Tabeen Jan**
Research Scholar, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Jammu and Kashmir, India

# Shelf life studies of the optimized chia-corn based snacks developed by extrusion processing

**Tabeen Jan, Syed Zameer Hussain, Saadiya, Aasima Rafiq**

**Abstract**
The aim of the study was to investigate the physical, chemical and sensory properties of chia enriched extruded snacks. The developed chia-corn extrudates were packed in high density polyethylene (HDPE) and low density polyethylene (LDPE) pouches. The developed chia-corn extruded snacks were stored for a period of six months and were evaluated at an interval 30 days for different parameters – breaking strength (N), peroxide value (mEq.$O_2$/Kg fat), free fatty acids (%), water activity (%), moisture content (%), total plate count (CFU/g) and overall acceptability. Results revealed that the packaging material as well as storage period had significant effect ($p$<0.05) on extruded chia-corn snacks. However, more changes in the quality parameters were observed in extrudates packed in low-density-polyethylene than in high density polyethylene pouches. The inference drawn from the study was that high density polyethylene pouches can be used to safely store the extruded snacks for a period of 6 months with least changes in the quality and safety of developed chia-corn extrudates.

**Keywords:** Shelf, optimized, chia-corn, snacks, processing

## Introduction

A healthy diet is crucial in preventing several diseases that are linked to civilization, including diabetes, cardiovascular disease, and obesity. In order to safeguard human health, prevent the onset of specific diseases, and treat their symptoms, both public and non-profit organizations make nutritional recommendations. The importance of bioactive food ingredients in supporting health is becoming more and more significant, these bioactive food ingredients are nutritional components or non-nutritional substances which are naturally present in the raw material or created in the product via technological processes that may improve, inhibit, or affect an organism's physiology and metabolism (Biesalski *et al.*, 2009) [5]. These bioactive active components include polyphenols, carotenoids, phytoestrogens, sterols, vitamins, dietary fibre, fatty acids, probiotics, prebiotics, and bioactive peptides. Recent years have seen a significant increase in interest in foods with plant origins, which have been the subject of numerous studies looking at how they affect health (Kulczyn´ski *et al.*, 2019) [11]. Salvia hispanica, generally known as chia, is an example of such raw material having characteristics that dietitians and food scientists find to be particularly intriguing. Chia seeds are considered to have a high nutritional value, in part as they contain a lot of dietary fibre and essential fats. Chia seeds provide more nutritional fibre than dried fruits, grains, or nuts. It is distinguished by having large concentrations of polyunsaturated fatty acids, particularly α-linolenic acid, which makes up around 60% of all fatty acids. (Ciftici *et al.*, 2012) [6] Chia seeds also contain a significant amount of plant protein, which makes up 18 to 22% of their weight. Chia seeds are gluten-free and can thus be consumed by people with celiac disease. Additionally, chia seeds include a variety of minerals Furthermore, the phyto-chemical compounds found in chia seeds are abundant and contain high biological activity, making them a particularly interesting source of phyto-compounds. (Nitryova *et al.*, 2014: Reyes-caudillo *et al.*, 2007) [13, 14].

Snack consumption has increased as a result of urbanization. Food- industries can take advantage of this development by creating wholesome snack foods. Extrusion has been widely used during the past 20 years because of its versatility, effectiveness, affordability, product quality, and environmental friendliness Snack foods, ready-to-eat cereals like corn, rice, and wheat baby foods, pasta, and pet foods are all manufactured worldwide using the technology of extrusion cooking (Deshpande and Poshadri, 2011) [7]. A food's shelf life is the amount of time during which it is safe to eat and/or is of a quality that consumers will accept. Extruded foods often contain high fat and low moisture content.

As a result, they are greatly impacted by changes in flavour, moisture, and oxygen. The main distinguishing quality of extruded snack foods is its hardness. The product's moisture content is crucial in preserving its hardness. Because of their extreme hygroscopicity, extruded items lose their crispiness when they absorb moisture, which also expedites other biochemical processes. This aim of the study was to determine the impact of storage time and packaging made of LDPE and HDPE on the quality characteristics of extruded functional snack foods made of chia and corn

**Material and Methods**

The raw materials that were used to formulate the nutritionally enhanced extruded snack came from a variety of sources. Corn flour (Var C-7) was purchased from the Sher-e-Kashmir University of Agricultural Science and Technology of Kashmir's Mountain Research Center for Field Crops in Khudwani. Chia seeds were procured from local supermarket of Srinagar. The chia seeds were ground in a lab-scale Cyclotec mill to a fine powder that easily passed through a 200-m sieve (CM 290 Cemotec TM). For further analysis, the ground chia seed flour and corn flour were kept in air tight containers. Packaging materials (HDPE and LDPE pouches) were procured from local grocery store.

**Extrusion process**

A co-rotating twin screw extruder was used for the extrusion trials (Basic Technology Pvt. Ltd., Kolkata, India). The extruder comprise of three zones, while the temperature in the first and second zones was kept constant at 60 and 80 °C throughout the experiment, the temperature in the third zone (the die section) was varied in accordance with the design of the experiment. The 4.0 mm circular die was employed for extrusion. Samples were produced in accordance with the obtained optimal conditions. The blends' moisture content was adjusted by conditioning them with moisture addition. Extrusion cooking was performed after following to the determined optimal conditions, and the chia-corn snacks were then packaged in two distinct packaging materials, namely High density polyethylene and low density polyethylene (LDPE), and kept for six months at room temperature (25–2 °C, 60–62 percent RH). Evaluation tests were conducted for moisture content, water activity, peroxide value (PV), free fatty acid (FFA), total plate count (TPC), and overall acceptability after 0, 60, 120,150 and 180 days.

**Moisture content**

For determining moisture content, the standard AACC (AACC, 2000) [1] protocol was used. 2 g of samples were dried in triplicate at 120 °C for an hour in a clean, dry, and previously weighed moisture dish. The samples were then dried to a consistent weight at 80 °C, cooled by placing it in desiccators, and then weighed. Moisture loss was calculated and expressed as percentage.

**Water Activity (aw)**

Water activity was determined by, means of water activity analyzer (AQUA, LAB, SN: PRE000197)

**Peroxide value**

A 250 ml conical flask was filled with a 5 g weighed sample. After adding 30 ml of the reagent I (acetic acid-chloroform solution), 0.5 ml of potassium iodide was added and the mixture was shaken. After shaking the solution slightly, 30 ml of distilled water was added. With continual shaking, the solution was titrated with 0.1N sodium thiosulphate until the yellow colour vanished. Then 0.5 ml starch solution was added, and the titration process was repeated until all the blue color vanished. The same procedure was followed for conducting blank tests. The peroxide value was estimated as peroxide per kilogram of material as

Peroxide

$$\text{Value} = \frac{(\text{Sample reading} - \text{blank reading}) \times \text{normality of Na2 S03}}{\text{weight of sample(g)}} \times 1000$$

**Free fatty acids (%)**

For the purpose of determining the presence of free fatty acids in extruded foods, the standard AOAC protocol (AOAC, 2000) [2] was followed. To extract free fatty acids, a product sample (5 g) was placed in a flask with 50 ml of benzene. This process was let to run for 30 minutes. Following extraction, a flask containing 5 ml of extract, 5 ml of benzene, 10 ml of alcohol, and phenolphthalein as an indicator was titrated against 0.02 N KOH until the bright pink colour vanished. The following formula was used to determine the fatty acid value:

$$\text{Fatty acid value as \% oleic acid} = \frac{282 \times 0.02\text{KOH} \times \text{ml of alkali} \times \text{dilution factor}}{1000 \times \text{wt of sample (g)}} \times 100$$

**Total plate Count (CFU/g)**

The microbiological stability of the extruded samples over time was evaluated using microbial analysis. 10 g of grated extruded sample was aseptically removed before being homogenized in 90 mL of the sterlized solution. For aerobic mesophilic bacteria, a three-fold serial dilution was performed, and each dilution was plated out in triplicates on nutrient agar plates using the spread plate technique. (Adegoke, 2004) [3] Plates were allowed to cool before being incubated at 37 °C for 48 hours. Using a digital colony counter, the number of visible colonies generated on each plate of various dilutions and colonies were counted and expressed as CFU/g as shown below.

CFU⁄g = No. of colonies × Dilution factor/Volume of sample used (ml)

**Overall acceptability**

Overall acceptability using a 9-point hedonic scale, from 9 (good) to 1 (poor), samples were judged for sensory qualities like appearance, colour, texture, flavour, mouth feel, and overall acceptability by a panel of semi-trained judges

**Result and Discussion**

Low density polypropylene (LDPE) and high density polyethylene (HDPE) were used to pack and store the developed chia corn snacks, which were stored at room temperature for 180 days. Every 30 days, tests were performed on the extruded chia-corn snacks to determine their overall acceptability (OA), moisture content, water activity, peroxide value (PV), free fatty acid (FFA), and total plate count (TPC). All of the parameters, including moisture content, water activity (aw), free fatty acids, peroxide value, breaking strength, overall acceptability (0A), and total plate count (TPC) of developed chia seed-enriched snacks, showed a significant ($p<0.05$) effect of both the packaging materials LDPE and HDPE as well as the storage period. The findings showed that the quality of chia-corn snacks was significantly ($p\leq0.05$) influenced by both packing and storage.

**Water activity and moisture content**

The amount of moisture and water activity, are thought to be important factors in determining how long extruded snacks can be stored. The moisture content increased significantly ($p<0.05$) in both packing materials, however the effect was more pronounced in chia-corn extrudates packed in LDPE than in HDPE pouches. The reason for the increase in moisture content during storage period can be attributed to the absorptive nature of extruded foods. (Sharma *et al*., 2004) [8] and storage environment as well as the nature of packaging material (Nagi, *et al*.,2012) [12] As LDPE has poor moisture-barricading qualities, samples stored in LDPE pouches absorbed the most moisture as compared to samples stored in HDPE pouches. The products' potential for shelf stability is indicated by the range of water activity levels (0.4–0.6). According to Jensen and Risbo (2007) [9], lipids are most resistant to oxidation when their water activity is between 0.3 and 0.6. Any value below 0.75 is regarded as adequate for inhibiting microbial development. For microbiological safety, the water activity of both chia-corn extrudates held in HDPE and LDPE under ambient conditions was within safe limits. Water activity in both packing materials showed a similar pattern. High water activity of extrudates in LDPE pouches may be caused by high water vapour permeability and moisture buildup during storage. Similar results were observed by Beigh *et al* (2019) [4] for water chestnut flour stored in LDPE pouches.

**Breaking strength**

Breaking strength of chia corn snacks decreased significantly ($p>0.05$) during storage from 8.165 N to 4.445 N for HDPE and 8.165 N to 4.323 N for LDPE, respectively. This decrease in storage may be caused by extrudates' ability to absorb moisture; since they are hygroscopic, less force is needed to break them. Beigh *et al.* (2019) [4] found comparable outcomes for water chestnut extrudates.

**Total plate count:** Due to the low moisture and water activity of the chia-corn snacks, the total plate count for the chia seed flour-corn based snacks stored in both the packaging materials, LDPE and HDPE, was too few to count (TFTC) after 120 days of storage. However, from the 120th day of storage, the total plate count for snacks packed and stored in LDPE was recorded as $1.5\times10^2$cfu/g and $0.65\times10^2$cfu/g for snacks packed and stored in HDPE until the end of the storage period, which was within the permitted limits established by ICMSF 2010, i.e. $10^6$cfu/g for ready-to-eat snacks.

**Free fatty acid and peroxide value:** Free fatty acid (FFA) percentage increased significantly during storage, from 0.140 (mEq O2/Kg fat) to 0.283 (mEq O2/Kg fat) in LDPE and to 0.310 (mEq O2/Kg fat) Peroxide value increased significantly ($p<0.05$) for developed chia- corn snacks packaged and stored in HDPE and for snacks packaged and stored in LDPE, respectively, from 0.140 to 0.283 percent and 0.140 to 0.310 percent. During storage in HDPE and LDPE pouches, a rise in the FFA percent of chia snacks was noticed, although it was determined to be within the allowed limits of 0.5 percent as set out by the (FSSAI) for food. As a result of oxidative rancidity during storage, these fatty acids develop (Khan *et al*., 2011) [10]. LDPE pouches had a higher percentage than HDPE ones, due to its poor oxygen barrier properties. PV values of chia-corn snacks in HDPE and LDPE pouches showed similar patterns in both of the packaging. Due to a poor oxygen and water vapour barrier, higher PV values were seen in LDPE. PV was, however, within the permissible range, which is 10 meq/100 g, for the items listed by (FSSAI).

**Overall acceptability**

Significant ($p<0.05$) changes in the overall acceptability (OA) of chia-corn snacks packaged and stored in LDPE and HDPE, respectively, were noted throughout storage. For snacks packaged in HDPE, OA reduced from 7.01 to 6.59, and for developed snacks packaged in LDPE, OA decreased from 7.01 to 6.31. Low sensory scores after storage were caused by the snacks losing some of their crunchiness due to increase in moisture content during storage, which was more pronounced for snacks packed in LDPE pouches than HDPE pouches Low sensory scores may also be caused by an increase in FFA and peroxide values during storage. Similar trends were observed by Altaf *et al.* (2021) [15] for chick-pea rice-based extrudates. The reason for low sensory scores during storage was due to a less crunchy texture of snacks as a result of moisture gain, which was more noticeable for chia- corn snacks packed in LDPE pouches than HDPE pouches.

**Table 1:** Effect of storage period and packaging materials on moisture content, water activity, and breaking strength of Chia seed incorporated snacks

| **Parameter** | **Moisture content (%)** | | **Water activity** | | **Breaking strength (N)** | |
|---|---|---|---|---|---|---|
| **Storage Period** | **HDPE** | **LDPE** | **HDPE** | **LDPE** | **HDPE** | **LDPE** |
| 0days | 2.340 | 2.340 | 0.194 | 0.194 | 8.165 | 8.165 |
| 60 days | 3.240 | 3.273 | 0.205 | 0.208 | 7.854 | 7.772 |
| 120 days | 3.847 | 3.887 | 0.212 | 0.216 | 6.565 | 6.434 |
| 150 days | 4.153 | 4.190 | 0.224 | 0.277 | 5.434 | 5.323 |
| 180 days | 4.547 | 4.590 | 0.227 | 0.230 | 4.445 | 4.323 |
| Mean | 3.625 | 3.656 | 0.212 | 0.215 | 6.494 | 6.404 |
| C.D($p<0.05$) | P=0.014<br>S=0.022<br>P×S= 0.036 | | P=0.002<br>S=0.003<br>P×S=0.005 | | P=0.001<br>S=0.002<br>P×S=0.003 | |

**Table 2:** Effect of storage period and packaging materials on free fatty acids, peroxide value, total plate count and overall acceptability of Chia seed incorporated snacks

| Parameter | Free-fatty acids (%) | | Peroxide value (mEq $O_2$/Kg fat) | | Total plate count $\times 10^2$cfu/g | | Overall acceptability | |
|---|---|---|---|---|---|---|---|---|
| **Storage period** | **HDPE** | **LDPE** | **HDPE** | **LDPE** | **HDPE** | **LDPE** | **HDPE** | **LDPE** |
| 0days | 0.140 | 0.140 | 0.240 | 0.240 | TFTC | TFTC | 7.01 | 7.01 |
| 60 days | 0.160 | 0.170 | 0.270 | 0.280 | TFTC | TFTC | 6.95 | 6.91 |
| 120 days | 0.190 | 0.210 | 0.290 | 0.310 | TFTC | TFTC | 6.69. | 6.61 |
| 150 days | 0.237 | 0.240 | 0.350 | 0.370 | TFTC | TFTC | 6.64 | 6.56 |
| 180 days | 0.283 | 0.310 | 0.410 | 0.427 | 1.5 | 0.65 | 6.59 | 6.31 |
| Mean | 0.202 | 0.214 | 0.312 | 0.325 | NA | | 4.061 | 3.926 |
| C.D ($p<0.05$) | P=0.009<br>S=0.015<br>P×S= 0.024 | | P=0.008<br>S=0.013<br>P×S=0.021 | | NS | | P=0.027<br>S=0.043<br>P×S=0.061 | |

## Conclusion

It can be concluded from this study, that quality attributes of chia-corn based extrudates were significantly affected by packaging material and storage period as well. Moisture content, water activity, free fatty acids and peroxide value of developed chia-corn extrudates increased in both packaging materials, while as overall acceptability decreased. However, higher increase in moisture, free fatty acids, peroxide value and microbial level were noticed in LDPE, in comparison to HDPE. The storage study results demonstrated that both packages and storage period had a significant ($p<0.05$.) effect on quality of chia –corn based snacks. However quality attributes of developed snacks were retained better in HDPE than LDPE pouches

## References


1. AACC, 10th ed. Approved Methods of the AACC International, American Association of Cereal Chemists, St Paul, MN, 2000, 4.
2. AOAC. 17th edn. Official methods of analysis.The Association of Official Analytical Chemists. Gaithersburg, Maryland, USA, 2000.
3. Adegoke G. Understanding Food Microbiology 2nd edition. Alleluia Ventures Ltd. Ibadan. Association of Analytical chemists Official Methods of Analysis of the A.O.A.C 15th Edition, 2004.
4. Beigh M, Hussain SZ, Naseer B, Rouf A, Raja TA. Storage studies of water chestnut flour, Journal of Food Processing and Preserveration, 2019, 44(2).
5. Biesalski HK, Dragsted LO, Elmadfa I, Grossklaus R, Muller M, Schrenk D, *et al*. Bioactive compounds: Definition and assessment of activity. Nutrition. 2009;25:11-12.
6. Ciftci ON, Przybylski R, Rudzin´ska M. Lipid components of flax, perilla, and chia seeds. Eur. J Lipid Sci. Technol. 2012;114:794-800.
7. Deshpande HW, Poshadri A. Physical and sensory characteristics of extruded snacks prepared from Foxtail millet based composite flours. Int Food Res J. 2011;18:751-756.
8. Sharma HR, Chauhan GS, Kuldeep Agrawal. Physico-Chemical Characteristics of Rice Bran Processed by Dry Heating and Extrusion Cooking, International Journal of Food Properties. 2004;7:(3):603-614.
9. Jensen PN, Risbo J. Oxidative stability of snack and cereal products in relation to moisture sorption. Food Chemistry. 2007;103:717-724.
10. Khan MA, Semwal AD, Sharma GK. Development and evaluation of long shelf-life ambient stable chapattis without the use of chemical preservatives. Journal of Food Processing and Technology. 2011;2:107-111.
11. Kulczynski B, Kobus-Cisowska J, Taczanowski M, Kmiecik D, Gramza-Michałowska A. The chemical composition and nutritional value of chia seeds Current state of knowledge. Nutrients. 2019;11:1242.
12. Nagi HPS, Kaur J, Dar BN, Sharma S. Effect of Storage Period and Packaging on the Shelf-Life of Cereal Bran Incorporated Biscuits, American Journal of Food Technology. 2012;**7**(5):301-310.
13. Nitrayova S, Brestensky M, Heger J, Patras P, Rafay J, Sirotkin A. Amino acids and fatty acids profile of chia (*Salvia hispanica* L.) and flax (*Linum usitatissimum* L.) seed. Potravinarstvo. 2014;8:72-76.
14. Reyes-caudillo, Tecante A, Valdiva-lopez AM. Dietary fibre content and antioxidant activity of phenolic compounds present in Mexican chia (*Silvia hispanica* L.) seeds. Food chemistry. 2007;107:658-663.
15. Shakoor A, Shahbaz M, Farooq TH, Sahar NE, Shahzad SM, Altaf MM, *et al*. A global meta-analysis of greenhouse gases emission and crop yield under no-tillage as compared to conventional tillage. Science of the Total Environment. 2021 Jan 1;750:142299.