

Original Research Article

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Effect of Packaging Material and Storage Period on Quality of Aonla and Cereal Based Extruded R-T-E Snack

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ABSTRACT

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Maize based extruded samples with rice and aonla powder (in the ratio of 80:10:10 respectively) extruded at the optimum conditions of 120°C barrel temperature, 350 screw rpm and 20% (d.b) were packed in three different packaging materials (LDPE, Aluminium foil and Aluminum foil pouches with Nitrogen gas) and stored at ambient conditions (25 to 30°C). It was found that the physical and nutritional changes are very less in aluminum foil with nitrogen gas compared with aluminium foil and LDPE pouch.

Introduction

Extrusion processing is an important technology used for producing a variety of expanded snacks and breakfast cereals (Agbisit *et al.*, 2007). The shelf life of a food can be defined as the time period within which the food is safe to consume and/or has an acceptable quality to consumers. Extrusion cooking technology is a relatively modern, high temperature-short time processing technology that was invented in 1940s to manufacture snack foods (Athar *et al.*, 2006). The advent of mechanized cooker extruders augmented the chances for generating a

myriad of snack foods and breakfast cereals. Generally extruded products have low moisture content and high fat content. Due to this they are highly affected by moisture, oxygen and changes in flavor. Hardness is the major characteristic property of extruded snack foods. Moisture content of the product plays a pivotal role in maintaining the hardness of it. Extruded products are very hygroscopic in nature and the moisture gain due to this characteristics leads to loss of crispiness of the product and also accelerates the other biochemical changes. Low value, typically traditional snack food and wafers may be branded or non-branded. Non –

branded snacks are packed for shorter shelf-life in unprinted low density polyethylene (LDPE) and aluminium foil (Packaging of snack food). For branded snacks and nuts laminated structures are used. The extension of shelf – life can be achieved through inert gas flushing which depends upon the product nature and the storage conditions. Another advantage of nitrogen flushing is that uniform pillow packs are produced, which prevent damage of the fragile snack products during handling and distribution. Proper selection and optimizing of packaging are of major importance to food manufacturers due to aspects such as e.g. economy, marketing, logistics, distribution, consumer demands, and the environmental impact of the packaging (Larsen *et al.*, 2005).

The objective of this study was to see the effect of LDPE packaging material and with or without Nitrogen gas flushing of Aluminum foil on the physical and nutritional parameters of the of the aonla, maize and rice based extruded snack food.

Materials and Methods

Extrusion cooking

Extruded samples of aonla, maize and rice powder in the ratio of 80:10:10 respectively were prepared in twin screw extruder at a temperature of 120°C barrel temperature, 350 rpm screw speed and 20% (w.b) feed moisture content. The extrudate samples were collected and dried at 60°C for 6 hrs in a tray drier to a maximum moisture content of 3.35 % (w.b). LDPE and Aluminium foil packages were procured from the local market.

Storage stability

Extruded samples were stored in different packages LDPE, aluminum foil and aluminum foil with Nitrogen gas packages (Plate 6.1).

10g of the extruded samples were packed in LDPE, Aluminum foil and Aluminum foil with nitrogen gas packages and then sealed with the sealer. Storage study was conducted at ambient temperature of 25 to 30°C) for 90 days. Observations like moisture content, texture, colour, Vitamin-C, FFA and total phenols and sensory score were recorded at 15 days interval after storage.

Data analysis

Data analysis was done by using SAS system. Two ways ANOVA was done by using Generalized Linear Model (GLM) procedure.

Results and Discussion

Effect of packaging material on moisture content of extrudates under ambient storage conditions

Moisture content of the samples was determined after every 15 days during the storage period. Initially the moisture content was 3.35% (w.b). However, the moisture content of the extruded samples increased during the storage in all the packaging material (table 2). The rate of increase of moisture content was faster in samples stored in LDPE pouches as evident from the table 1.

The samples in LDPE achieved 5.1% moisture content whereas the samples in al foil and laminated films with Nitrogen gas got 4.86 and 4.32% respectively by the end of 90 days of storage. Analysis of variance (ANOVA), shown in Table 2 indicated significant effect of packaging material, storage days individually and their interaction on change in moisture content ($P < 0.005$). From the letter grouping it is evident that all the packaging material and storage days individually and interaction also significantly differ from each other and maximum moisture content was in LDPE film after 90 days of storage (Table 2)

Effect of packaging material on hardness of extrudates under ambient storage conditions

Effect of packaging material and storage period on maximum peak force (hardness) is presented in table 3. It was observed that hardness decreased with the increase in the storage days in all the packages due to moisture observation from the surrounding atmosphere. The LDPE pouches was a less hardness and maximum in aluminium pouches. In LDPE pouch the hardness decreased drastically up to 30 days of storage and then it was almost constant. In case of aluminium foil and aluminium foil with nitrogen gas there was a slowly decreases in the hardness of the extrudates.

Analysis of variance (Table 3) revealed that both packaging material and storage days individually and their interaction had a significant effect on the hardness of the extrudates ($P < 0.05$). It was also observed through Table 2 for letter grouping that LDPE had significant difference on hardness from 0 to 30 days of storage and no significant difference between 30, 60, 90 days of storage. Hardness of the samples in aluminium foil with nitrogen gas is not significantly different at 60 and 75 days of storage.

Effect of packaging material on total colour change of extrudates under ambient storage conditions

Colour is considered as one of the most important external quality factor of the extruded products, as the appearance of the product greatly influences the consumers.

Change in colour of the extruded product in all the packages at different storage periods was measured and is presented in table 4. It is clear from the table 4 that the change in colour of the samples increased with storage in all the

packages. Colour change was observed more in LDPE followed by Aluminium foil with and Aluminium foil Nitrogen gas respectively.

Analysis of variance revealed that both the packaging material and days of storage had significant effect on colour change of the extrudates individually and their interaction ($P < 0.05$).

It was also observed through letter grouping (Table 4) that colour change was significantly different at 0, 15, 30, 45, 60, 75 and 90 days of storage for all the packages except for LDPE with Nitrogen gas where there was no significant difference at 60 and 90 days of storage.

Effect of packaging material on total phenolic content of extrudates under ambient storage conditions

Total phenolic content of the samples was evaluated during the storage and represented in Table 5. It was found that total phenolic content decreased in all the packages with storage period.

However, the rate of loss in total phenolic content was higher in LDPE pouch as compared to Aluminium foil and Aluminium foil with Nitrogen gas. It was observed that the retention of total phenolic content was 92.8, 96.29 and 98% in LDPE, Polypropylene and Aluminium foil with Nitrogen gas respectively after 180 days of storage.

Analysis of variance (Table 6.11) shows that packaging material and days of storage individually and their interaction had significant effect on total phenolic content ($P < 0.05$). It was also observed from the letter grouping (Table 6.12) that in case of laminated film there was no significant difference in the total phenolic content up to 15 days of storage.

Effect of packaging material on Vitamin C content of extrudates under ambient storage conditions

The Vitamin-C content of the samples was evaluated during the storage and represented in Fig 6.6. It was found that vitamin-C content decreased in all the packages with storage period. However, the rate of loss in vitamin-C content was higher in LDPE pouch as compared to Polypropylene with Nitrogen gas and Aluminium foil with Nitrogen gas.

It was observed that the retention of vitamin-C content was 75, 78.05 and 80.5% in LDPE, LDPE with Nitrogen gas and Aluminium foil respectively after 180 days of storage.

Analysis of variance (Table 6.11) shows that packaging material and days of storage individually and their interaction had significant effect on total phenolic content ($P < 0.05$). It was also observed from the letter grouping (Table 6.12) that in case of Aluminium foil there was no significant difference in the total phenolic content up to 15 days of storage.

Effect of packaging material on FFA content of extrudate under ambient storage conditions

FFA is considered as one of the most important internal quality factor of the extruded products for storage studies because it leads to the formation of rancidity in the product. The FFA content of the samples was evaluated during the storage and represented in Fig 6.6. It was found that vitamin-C content increased in all the packages with storage period. However, the rate of increase in FFA content was higher in LDPE pouch as compared to Polypropylene and Aluminium foil with Nitrogen gas. Analysis of variance (Table 6.11) shows that packaging material and days of storage individually and their

interaction had significant effect on FFA ($P < 0.05$). It was also observed from the letter grouping (Table 6.12) that in case of Aluminium foil there was less formation of FFA compared in the other packaging material.

Effect of packaging material on moisture content of extrudates under ambient storage conditions

The moisture content of the samples at the end of 90 days of storage was found to be more in LDPE films (5.1%) than aluminium foil (4.86%) and Aluminium foil with Nitrogen gas (4.32%) probably due to the less permeability of the aluminium pouches.

The inert gas nitrogen in the aluminium pouches film also reduced the absorption of moisture. Sowbhagya *et al.*, (2005) reported a gradual increase in moisture content from about 6% to about 11% at the end of 10 weeks in case of extruded samples of corn flour and defatted soya flour coloured with curcumin and tartarazine packed in 30 μm thick polypropylene pouches at ambient storage condition.

Effect of packaging material on hardness of extrudates under ambient storage conditions

During the storage the extruded samples lost their crispness and became smooth. As the moisture absorption was more in LDPE than the aluminium and aluminium foil with nitrogen gas so hardness was more in the samples stored in aluminium pouches.

This might be due to the binding action of the sugars present in cereal powders after absorption of moisture. Larsen *et al.*, (2005) reported that the crispiness of the oat extruded samples was strongly negatively correlated to the water activity.

Table.1 Properties of packaging materials

Packaging Material	Thickness (µm)	WTR (kg of water/day)	GTR
LDPE	30	7.4×10^{-3}	7.34×10^{-3}
Al foil	60	4.3×10^{-3}	4.89×10^{-3}

Table.2 Effect of packaging material and storage days of Moisture content on the extruded snacks

No. Days	LDPE	Al. foil	Al foil (N)
0	3.35	3.35	3.35
15	4.1	3.98	3.78
30	4.5	4.32	4.12
45	4.7	4.56	4.20
60	4.9	4.76	4.24
75	4.98	4.79	4.27
90	5.1	4.86	4.32
CD			
(p≤0.05)	SD=0.084		
	P×S=0.147		

Table.3 Effect of packaging material and storage days on Hardness of the extruded snacks

No. Days	LDPE	Al.Foil	Al. Foil (N)
0	16.80	16.80	16.80
15	16.20	16.30	16.60
30	15.50	15.79	16.20
45	15.18	15.34	16.08
60	14.86	15.12	15.89
75	14.30	14.87	15.50
90	14.01	14.56	15.34
CD	PM=0.116		
(p≤0.05)	SD=0.242		
	P×S=0.420		

Table.4 Effect of packaging material and storage period on total colour change of the extrudates

No. Days	LDPE	Al. Foil	Al Foil (N)
0	48.21	48.21	48.21
15	47.27	47.60	48.04
30	46.16	46.77	47.84
45	45.52	45.71	46.60
60	44.73	45.33	46.43
75	44.13	44.55	46.07
90	43.56	44.51	45.67
CD	PM=0.252		
(p≤0.05)	SD=0.166		
	P×S=0.288		

Table.5 Effect of packaging material and storage period on total phenolic content of the extrudates

No. Days	LDPE	Al foil	Al foil (N)
0	247.80	247.80	247.80
15	247.65	247.75	247.75
30	247.70	247.15	247.65
45	239.75	246.35	247.70
60	232.15	245.35	247.35
75	227.75	244.25	247.00
90	222.55	242.85	246.95
CD	PM=0.572		
(p≤0.05)	SD=1.192		
	P×S=2.06		

Plate.1 Extrudates packed in different packaging materials



Table.6 Effect of packaging material and storage days on Vitamin-C content of the extruded snacks

No. Days	LDPE	Al foil	Al foil (N)
0	207.50	207.50	207.50
15	202.55	204.00	206.15
30	198.90	200.90	204.05
45	195.05	199.00	202.75
60	191.65	196.00	199.70
75	187.95	193.85	197.20
90	184.90	190.10	196.10
CD	PM=0.419		
(p≤0.05)	SD=0.874		
	P×S=0.514		

Table.7 Effect of packaging material and storage days on FFA content of the extruded snacks

No. Days	LDPE	Al.Foil	Al. Foil (N)
0	0.32	0.32	0.32
15	0.38	0.36	0.35
30	0.44	0.38	0.36
45	0.50	0.45	0.39
60	0.58	0.51	0.43
75	0.64	0.57	0.47
90	0.71	0.63	0.52
CD	PM=0.012		
(p≤0.05)	PM=0.025		
	PM=0.044		

Plate.2 Nitrogen gas filling and sealing machine



Effect of packaging material on colour change of extrudates under ambient storage conditions

The colour change of the samples stored in the aluminium foil with nitrogen gas and aluminium foil was less than samples stored in LDPE film which might be due to the less non enzymatic browning in the aluminium foil with Nitrogen gas and aluminium foil pouches (with less moisture content and water activity).

Effect of packaging material on total phenolic content of extrudates under ambient storage conditions

Total phenolic content of the samples stored in different packages also followed the similar trend of the vitamin content.

Total phenolic content of the extruded samples decreased during storage in all the packages with maximum decrease in LDPE and less decrease in Aluminium foil with Nitrogen gas and aluminium which might be due to the less permeability of the laminated pouches with the presence of Nitrogen gas within film which might have reduced the oxidation of the compounds.

Effect of packaging material on vitamin C content of extrudate under ambient storage conditions

Total vitamin c content at the end of 90 days storage in LDPE, aluminium and Aluminium foil with Nitrogen gas was 184.90, 190.10 and 196.10 mg/100g respectively. A loss of 21.6, 15.1 and 12% was observed in LDPE, aluminium foil and Aluminium foil with Nitrogen gas respectively after 90 days of storage. Bhavani and Kamini, (1998) also reported a loss of 10.78% in the β -carotene content of the extruded samples stored for four weeks at a mean temperature of 36.6°C and

32.2% humidity in high density polyethylene (HDP) bags.

Effect of packaging material on FFA content of extrudates under ambient storage conditions

Total FFA content of the extruded samples increased during storage in all the packages with maximum increase in LDPE and less increase in Aluminium foil with Nitrogen gas and aluminium foil, which might be due to the less permeability of the laminated pouches and the presence of Nitrogen gas within the Aluminium foil with Nitrogen gas which might have reduced the oxidation of the compounds

From the results it can be concluded that aluminium foil with nitrogen gas is the best to store the extruded products up to 90 days of storage. LDPE film can also be used for attaining the almost similar results of aluminium foil as there was not much difference between these two.

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