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Assessment of Storage Stability of Whole and Degermed maize flours

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Abstract

In present communication, effect of packaging materials and storage periods on biochemical qualities of whole and degermed maize flours were investigated. The flours were packed in three different packaging materials viz. aluminium laminated foil (ALF), high density polyethylene (HDPE) and low density polyethylene (LDPE) packages and its biochemical qualities were determined at every ten days storage interval for 70 days. Degermed maize flour was found better in terms of moisture, protein, fat, ash, FFA and alcoholic acidity as compared to the whole maize flour. The moisture, FFA and alcoholic acidity were increased whereas protein, fat and ash contents decreased with increase in storage interval. The moisture, fat, protein, FFA and alcoholic acidity were significantly affected by storage time and packaging material whereas the ash and crude fibre varied non-significantly. Both whole and degermed maize flours, stored in ALF packages, were found best followed by HDPE.

Key words: Maize Flour, Storage, Packaging Material, Biochemical Properties

Introduction

Maize (Zea Mays L.) is an important staple food in many countries of the world. The acreage and production of maize in the world have been increasing continuously. India is the fifth largest producer of maize in the world contributing 3% of the global production. It can be processed into different breakfast items, food and feed ingredients and beverages for its consumption throughout the world (Chakraverty, 1988; Rajoo, 1998). Many people throughout the world, particularly living in Asia or people of Asiatic origin, make their own dough-based products on a daily basis. There are five general classes of corn e.g. flint corn, popcorn, flour corn, dent corn, and sweet corn (Watson, 1987a). Different types of corn have different proportions of horny and floury endosperm. The floury endosperm is softer and easier to break than the horny endosperm. Different parts of corn have different physical and chemical proper-ties. Yellow corn has a horny endosperm and more carotenoids (74–86%), which are the source of yellow color in corn (Watson, 1987b). Hardness and breakage susceptibility are related properties that can affect the utilization of corn (Pomeranz et al., 1984). Maize germ constitutes 5-14% of the weight of kernel and is a good source of key nutrients especially 18-41% of oil (Johnston et al., 2005); MPOC, 2008).

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Edible oils are vital, serving as important ingredient of many foods by imparting characteristic flavor and texture to finished food products (Rudan-Tasic and Klofutar, 1999). Chemical and physical properties of edible oils are imperative as they tie up with processing functionality, storage stability and nutritional behavior. In India, maize has become the third important food grain after wheat and rice. Chapatti is most often in the form of round substantially flat pieces of dough, which are appropriately cooked/ baked. Chapatti is the staple diet of a majority of people living in the Indian subcontinent. Corn flour is used to make chapattis, which are eaten commonly in most part of India. By and large, corn breads are more commonly consumed by the less affluent people (Mehta and Dais, 1999). Sinha and Sharada (1992) compared the chapatti-making properties of corn flours, before and after al-kali treatment, and reported that untreated chapattis were more acceptable than treated ones. The desired quality parameters in chapatti are greater pliability, soft texture, light creamish brown colour, slight chewiness and baked aroma, which is usually prepared from flour (Rao et al., 1986).

The present study was carried out to study the bio-chemical qualities of whole and degermed maize flours stored in three different packaging materials viz. aluminium laminated foil (ALF), high density polyethylene (HDPE) and low density polyethylene (LDPE) during storage.

Material and Methods

Raw material. Whole maize kernels (cv. *PMH–1*) were procured from Maize section, Punjab Agriculture University Ludhiana, India for the present study. The maize kernels were cleaned by using pedal cum power operated grain cleaner (top sieve: 8.0 mm Φ; bottom sieve: 2.0 mm × 2.5 mm) to remove foreign matter such as dust, dirt, chaff, immature and broken grains. The proximate composition i.e moisture, fat, protein, ash, crude fibre and carbohydrates of cleaned cum graded corn kernels are determined as per standard procedures (AOAC, 1980).

Sample Preparation. The cleaned and graded whole maize kernels were divided into two parts. The first part of it was ground to make powder using burr mill whereas second part of maize was processed through CIPHET maize degermer to separate the maize grit and maize germ. Degermed maize grit was ground to make powder using burr mill and sieved for uniform particle size. Whole maize and degermed maize flours were packed in triplicate in three packaging materials (ALF, HDPE and LDPE) for 70 days storage period with 10 days storage interval. For determination of biochemical qualities, separate packet for each storage interval were used and discarded after each storage studies.

Storage Stability Parameters

Moisture Content. The moisture contents of the samples were determined using Kern Moisture Analyzer (Model: KERN, MLB 50-3N, Kern & Sohn GmbH, D- 72336 Balingen, Germany).

Protein content. Protein content was determined by available nitrogen in the sample by Micro Kjeldhal method (AOAC, 1980). One gram sample was digested in 20 ml of sulphuric acid (H_2SO_4) at 420^{o}C using copper sulphate and potassium sulphate as catalyst mixture. Digested sample was distilled using 40% NaOH in KjelTech (Pelican equipment Limited, Chennai, India). Ammonia was absorbed in excess of 4% boric acid solution and then titrated with standard acid (0.1N HCl) to estimate the protein content. The protein content was estimated using following equation:

$$N_2 = \frac{(Sample\,titre - Blank\,titre) \times Normality\ of\ HCl \times 14 \times 100}{Weight\ of\ sample\ taken \times 1000}$$

and Protein (%)= 6.25×Nitrogen (N_2)content (%)

Crude Fat . Moisture free 5 g sample was taken in readymade thimble and oil was extracted in a pre-weighed beaker using petroleum ether in SOCS PLUS (Pelican Equipment Limited, Chennai, India) for 2.5 to 3 hours. The beaker was then dried in a hot air oven to evaporate petroleum ether. Final weight of the beaker was taken and used for the estimation of crude fat content of sample (AOAC, 1980). The following equation was used for estimation of crude fat content (%) in the sample:

$$Crude\ fat\ \ (\%) = \frac{Weight\ of\ \ fat\,(g) \times 100}{Weight\ of\ sample(g)}$$

Ash content. Samples (5 g) are taken in triplicate in crucibles. These were burnt on hot plate and then placed in an electric muffle furnace at 600^o C for 6 hours. After cooling the crucibles to room temperature, the residue left (ash) in the crucible was weighed (AOAC, 1980). The following formula was used to calculate the ash (%):

$$Ash\ \ (\%) = \frac{Weight\ of\ ash \times 100}{Weight\ of\ sample}$$

Crude fibre . Two grams of moisture and fat free sample was first digested with 200ml boiling 0.255N H_2SO_4 for 30 min. After acid digestion the mixture was filtered and washing of residue with hot water was carried out to remove traces of acid. Then alkali digestion was performed with 200 ml of 0.313 N NaOH for 30 min. Again the mixture was filtered and washed with hot water followed by alcohol and ether to remove traces of alkali. The residue was dried and weight was noted down (M_1). It was ignited in muffle furnace at 600℃ for 3 hours and cooled and weighed (M_2). The following equation was used for estimation of crude fibre content (%) in the sample (AOAC, 1980):

$$\text{Crude fiber, \% by mass (on dry basis)} = \left(\frac{M_1 - M_2}{M}\right) \times 100$$

Where, M is mass in g of the dry fat free sample taken for the test.

Carbohydrates. Carbohydrates were calculated by subtraction method.

Alcoholic acidity. The alcoholic acidity was determined by using the procedure, given by Thapar et al. (1988). 5 g of sample with 50 ml alcohol was mixed and kept for 24 hrs with occasional swirling. The mixture was filtered and 10 ml of extract was titrated with 0.05N NaOH solution using phenolphthalein as indicator. The alcoholic acidity was calculated as follows:

$$Alcoholic\ acidity\ as\ H_2SO_4 = \frac{Vol..of\ \ titre \times 0.00245 \times 50 \times 100}{10 \times 5}$$

Statistical analysis. The data obtained from the experiments were statistically analyzed for analysis of variance (ANOVA) with two factor analysis using LSD of AgRes software.

Results and discussion

Moisture content. Moisture content of flour is very important for its shelf life, lower the flour moisture, the better its storage stability (Butt et al., 2004). From Figure 1, it can be depicted that moisture content of whole and degermed maize flour is found to increase with increase in storage period. Relative humidity and temperature during storage are two major factors that affect overall quality of the product. High humidity gives rise to high moisture content, which is conducive for enzymatic hydrolysis of the fat present in food products (Mridula et al., 2009). The increase in moisture content irrespective of packaging

materials may also be attributed due to hygroscopic properties of flour. The effect of packaging material and storage time is shown in Table 1.

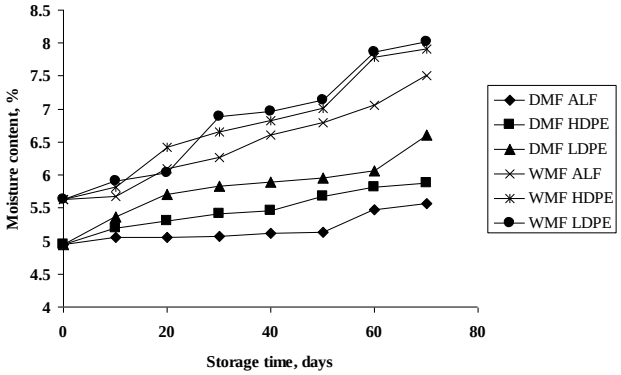

Fig 1. Effect of storage time and packaging material on moisture content of whole and degermed maize flours

Table 1. Analysis of variance for biochemical properties of whole and degermed maize flours

Source	F-value						
	Moisture	Protein	Fat	Crude fibre	Ash	Carbohydrate	Alcoholic acidity
PM	104.63*	301.85*	964.41*	351.60^{NS}	359.94^{NS}	2395.47*	326.83*
d	31.34*	23.56*	2.67*	6.53^{NS}	1.59^{NS}	55.66*	276.34*
PM×d	3.90*	1.59*	2.21*	1.22^{NS}	1.33^{NS}	3.58*	5.35*

*† PM – packaging material; d- days; * Significant at 1% level*

However the moisture content of degermed maize flour was found to be less as compared to whole maize flour. Also little variation was observed in aluminium laminates as compared to HDPE and LDPE due to low water vapor transmission properties. The increase in moisture contents were within the maximum permissible limit of 13.0% suggested by BIS (Bureau of Indian Standard) standard for maize *atta* (flour). It may be due to the suitability of the packaging material for storage of product with fluctuating atmospheric conditions. From the analysis of variance it is found that moisture content is significantly affected by storage time, packaging material and their interaction. Butt et al. (2004) also reported that the moisture content was affected significantly due to storage, treatments, packaging and their interaction.

Protein content. The protein content in both degermed maize and whole maize flours were decreased with increase in storage interval (Figure 2). However more decrease is observed in whole maize flour irrespective of packaging material. This may be due to the fact that whole maize flour has high moisture content as compared to degermed maize flour as high moisture content in whole maize flour favoured proteolytic activity. These are in accordance with Butt et al. (2004) who reported that the crude protein content showed a decreasing trend with storage of wheat flour. Little change was observed in degermed maize flour in aluminium laminates. The reason may be removed germ and better protection properties of aluminium laminates. The higher protein content was observed in whole maize flour. It may be due to the presence of germ in the flour which might have contributed in total quantity (Siddiq et al., 2009). From Table 1, it's clear that storage days and packaging material are highly significant at $P<0.05$ and interaction between storage period and packaging materials are highly significant.

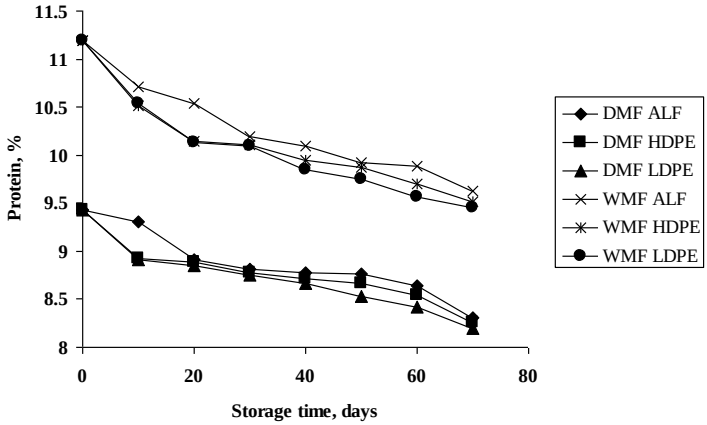

Fig 2. Effect of storage time and packaging material on protein content of whole and degermed maize flours

Crude fat content.

More amount of fat content in the flour will lead to rapid degradation leading to poor keeping quality, so fat content of the product is also limiting factor for good shelf life of flour. The variation of crude fat with packaging material and storage time is depicted in Figure 3. From the figure, it can be described that the fat content decreased with increase in storage period. The decrease may be attributed due to the lipolytic activity of enzymes (Butt et al., 2004).

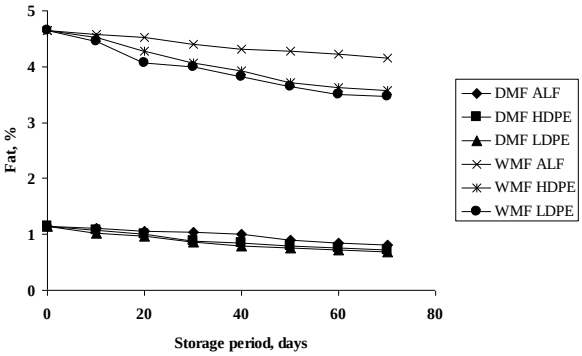

Fig 3. Effect of storage time and packaging material on fat content of whole and degermed maize flours

However the fat content was less in degermed maize flour which is attributed due to removal of germ. The main component responsible for fat in maize is germ, which is

responsible for fat content in it. From analysis of variance it can be observed that fat content is significantly affected by packaging material, storage time and their interaction. Nevertheless the less variation is observed in degermed maize flour packed in aluminium laminates as compared to HDPE and LDPE which is again due to germ removal and barrier properties of aluminium laminates.

Ash content. The ash content of whole and degermed maize flour varied from 1.56 – 1.77 and 0.53 – 0.58 respectively. Higher ash content is observed in whole maize flour as compared to degermed maize flour. This may be due to the fact that all of the constituents viz pericarp, germ etc are present in whole maize flour which add to increased ash content compared to degermed maize flour. The ash content is not significantly affected by packaging material and storage period. Similar findings are reported for suji, wheat flour and composite flours (Upadhyay et al., 1994; Butt et al., 2004; Shahzadi et al., 2005).

Crude fibre. The crude fibre content of whole and degermed maize flours varied from 1.42–1.73 and 0.49 - 0.80 respectively, during the storage period. Also the crude fibre content is found to be less in degermed maize flour as compared to whole maize flour. This may be due to the fact of germ removal. Crude fibre content is not significantly affected by packaging material and storage time. The results for crude fibre are analogous to the findings for suji and whole wheat flour **(**Upadhyay et al., 1994**;** Butt et al., 2004**).**

Carbohydrates. The variation of whole and degermed maize flour with packaging material and storage time is described in Figure 4. From the figure, it can be depicted that carbohydrates decreased with storage in whole and degermed maize flour despite of packaging material. This may be attributed due to the changes in starch as a result of endogenous amylolytic activity (Rehman and Shah, 1999).

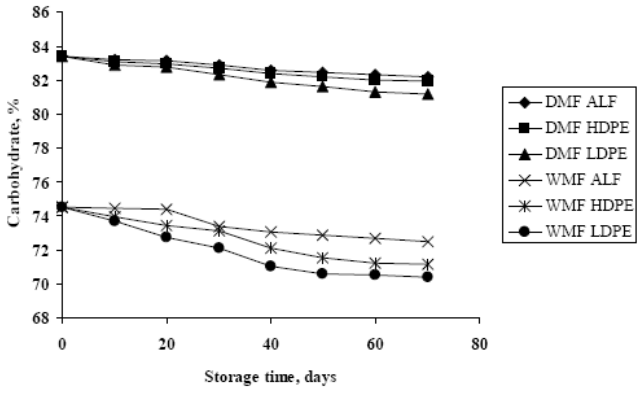

Fig 4. Effect of storage time and packaging material on carbohydrates of whole and degermed maize flours

Although the carbohydrate content of whole and degermed maize flour vary diminutively. The carbohydrate content of whole and degermed flour is significantly affected by storage time, packaging material and their interaction

Alcoholic acidity. Alcoholic acidity, in both degermed maize and whole maize flours, were increased with increasing storage interval irrespective of all the packaging materials (Figure 5).

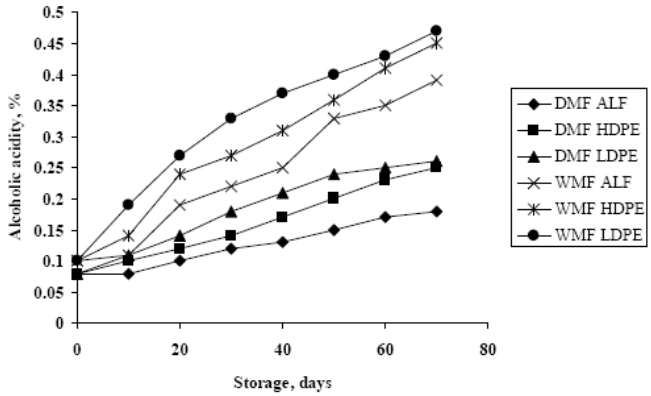

Fig 5. Effect of storage time and packaging material on alcoholic acidity of whole and degermed maize flours

However the rate of increase being higher in LDPE packages followed by HDPE packages and ALF packages. The minimum alcoholic acidity is found in degermed maize flour packages which may be due to removal of germ prior to milling. Also the whole maize flour has high moisture content as compared to degermed maize flour which is also responsible for higher alcoholic acidity. As higher ingress of moisture by whole maize flour, the increase in alcoholic acidity will also be higher upon storage (Upadhyay at al., 1994). This is evidenced by comparatively low alcoholic acidity in degermed maize flour which has the lowest water vapour permeability rate amongst all packaging materials used in this study. The degermed flour was found to be safe for consumption even after 60 days of storage in all the three packaging materials however the whole maize flour was fit for consumption for 40-50, 30 - 40 and 20 days in ALF, HDPE and LDPE packages, respectively depending upon the maximum permissible limit of alcoholic acidity (0.3% BIS specification).

The present investigation revealed that the degermed maize flour lower moisture content, protein, ash, crude fibre and alcoholic acidity as compared to whole maize flour. The degermed maize flour has better keeping quality as compared to whole maize flour irrespective of the packaging material. The maize flour can be best kept in ALF packages followed by HDPE and LDPE packages. The degermed maize flour could be safely consumed for 60 days in all the packaging materials whereas the whole maize flour could be safely used for 20, 30-40 and 40-50 days packed in LDPE, HDPE and aluminium laminated foil packages, respectively.

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