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Effect of Packaging Materials and Storage Condition on Functional and Pasting properties of Wheat Flour

Vanmathi Mugasundari. A[1,2], and S. Anandakumar[1*]
Department of Food Packaging and System Development
[1]National Institute of Food Technology Entrepreneurship and Management,(formerly IIFPT)Thanjavur, India
(Ministry of Food Processing Industries, Government of India)
[2]Affiliated to Bharathidasan University, Palkalaiperur, Tiruchirappalli – 620024, Tamil Nadu, India
*Corresponding author's*Email: anand@iifpt.edu.in

ABSTRACT
In this present study, freshly milled wheat flour samples were packed in different packaging materials such as bioplastic (BP), polypropylene (PP), and polyethylene (LDPE) and stored for 90 days at atmospheric storage condition. The effect of packaging materials on the stored wheat flour properties were evaluated at 15 days interval during the storage. The highest bulk density of stored wheat flour were recorded as0.811 g/ml(PP), followed by0.801 g/ml (BP), and 0.777 g/ml (LDPE), respectively. The results indicated that the maximum water absorption capacity was obtained in 3.971g/g (LDPE), 3.229g/g (PP), and 2.864 g/g (BP).The swelling power, water absorption index of stored wheat flour were found in the range of 1.378 to 3.277g/g, and 4.615 to 12.760 g/g, respectively. During storage, the solubility index of wheat flour decreased from 6.955 to 2.720 %. Significant difference (p <0.05) were observed on stored wheat flour in different packaging materials and storage period. The pasting properties, and the viscoelastic properties of wheat flour during storage were evaluated.
Keywords: *bioplastic, storage period, packaging material, functional, pasting*

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INTRODUCTION

Wheat (*Triticum aestivum*) is one of the commonly cultivated cereal crop in global level. Wheat is a staple food in many parts of the globe due to its high carbohydrate-fiber content (1). Wheat is the first and basic raw material used for flour production and subsequent bread making (2). Wheat has rich carbohydrate (69.47%) and protein (14.88%) contents (3). During storage, the grains undergo various biochemical changes due to humidity and storage temperature. Changes in acidity, pH, free amino nitrogen, crude protein can be witnessed during long-term storage of wheat. Longer storage of wheat flour greatly affects the moisture levels, gluten content and enzymatic activity (4).

The physico-chemical properties that reveal the interaction between composition, structure, and molecule conformation are known as functional properties. The percentage of water bound per gram of flour was used to assess water absorption (5). Swelling tests are basic measurements of water absorption during the gelatinization of starch. In wheat starches, amylopectin is intended to help in water absorption, swelling, and pasting of starch granules, whereas amylose and lipids seem to slow down these processes. (6).Pasting Properties of wheat starches with increased amylose content showed a decrease in peak, breakdown and final viscosities. Final Viscosity indicates the retrogradation of starch molecules into gel or semi crystalline aggregates. Wheat flours stored at 20 and 30°C showed an increase in final viscosity values attributed to the presence of fatty acids and monopalmitin. (7).

Polymeric composites, such as polyethylene and polypropylene, are widely used in food packaging because of their favourable mechanical characteristics, flexibility, ease of use, low cost, light weight, durability, and heat stability (8). Synthetic packaging materials have a number of drawbacks, including pollution, non-biodegradability, and incineration, which releases more carbon dioxide into the atmosphere. Biodegradable plastics are the promising solution for this problem, because they are ecologically friendly, renewable, and degrade in the environment easily (9).

Wheat may be stored as grain for several years, however flour is only kept for a few months. Many studies have shown that the constituents of wheat grain and flour undergo age-dependent changes during storage that are influenced by temperature and moisture, and that these changes can affect functional and nutritive characteristics, resulting in beneficial or detrimental quality effects depending on the end use. Hence, this study was aimed to evaluate the effect of different packaging materials such as bioplastic (BP), polypropylene (PP), and low density polyethylene (LDPE) on functional and pasting properties of wheat flour stored at ambient conditions.

MATERIAL AND METHODS

Sample preparation

Wheat grains was purchased at a local market in Thanjavur, Natarajan & Co, and ground into flour in local mill. Fresh wheat flour was packed and sealed in different types of materials, such as BP, PP, and LDPE, and kept at ambient temperature for 90 days.

Properties of wheat flour

Bulk density

Bulk density was measured by the method described by (10). In a 100 ml graduated measuring cylinder, about 10.0 g of flour sample was added and gently tapped until a constant volume was obtained and then, the volume was noted. The bulk density was calculated by using the following equation:

$$Bulk\ density\ \left(\frac{g}{ml}\right) = \frac{Weight\ of\ dry\ sample}{\text{Volume of sample}} \quad (1)$$

Dispersibility

Dispersibility was determined using the procedure of (11). About of 10 g of flour sample was added into 100 ml graduated cylinder, followed by addition of distilled water to reach a volume of 100 ml. After that, the sample was mixed thoroughly and allowed to settle for 3 hours. The settled particles volume were recorded and dispersibility was calculated using the following equation

$$Dispersibility\ (\%) = 100 - \text{volume of settled particle} \quad (2)$$

Water absorption capacity

Water absorption capacity was measured by the method described by (12). One gram of wheat flour sample was dissolved in 10 ml of distilled water and left at room temperature for 30 minutes. The mixture was centrifuged (Model: REMI R-8C, Micro centrifuge) at 3000 rpm for 30 minutes and the supernatant was gently decanted. The WAC was determined by measuring the amount of water absorbed per gram of flour(12).

$$WAC\ \left(\frac{g}{g}\right) = \frac{W_2 - W_1}{\text{W}} \quad (3)$$

Where,

W_1- Weight of centrifuge tube and sample (g),
W_2 - Weight of centrifuge tube and sediment (g),
W –Weight of dry sample (g).

Swelling power, water absorption and solubility index

According to Kaushal et al., (2012), the swelling power, water absorption index, and water solubility index of flour were measured. About 2.5 g flour sample was dispersed in 30 ml distilled water and cooked at 90 °C for 10 mins in a water bath (Model: REMI RWB 6). Then, the sample was cool down in room temperature and again centrifuged (Model: REMI R-8C, Micro centrifuge)at 3000 rpm for 10min. After centrifugation, the supernatant was decanted from the sediment into an evaporating aluminium dish that had been pre-weighed to determine its solid content. By evaporating the supernatant overnight at 110°C in hot air oven (Model: REMI RDHO 50), the weight of dry solids was recovered. The SP, WSI, and WAI of flour samples values were calculated using the following equations.

$$SP\ \left(\frac{g}{g}\right) = \frac{W_s}{W_o - W_{ds}} \quad (4)$$

$$WAI\ \left(\frac{g}{g}\right) = \frac{W_s}{W_O} \quad (5)$$

$$WSI\ (\%) = \frac{W_{ds}}{W_o} \times 100 \quad (6)$$

Where,

SP - swelling power, WAI - water absorption index, WSI - water solubility index, W_s- weight of sediment (g), W_{ds}- weight of dry supernatant (g), W_o– weight of dry sample (g).

Gluten content

25 g of wheat flour sample was taken into a bowl, added 15 ml of water, and knead it into a dough, making sure all of the content is incorporated. The setup for allowed 1 hour for the dough to rest gently in a beaker filled with water. Remove the dough and washed with tap water continuously in a piece of white plain muslin cloth with an aperture of 0.16 mm. Collect the residue into a ball, squeeze out any excess water with your hands, transferred to petri dish, and kept in the oven at 105 °C for drying. After that the gluten was removed and cut into several pieces, again place back in the oven for complete dry(14). The gluten content was calculated using the following equation

$$\text{Gluten content \% (d.b)} = \frac{\text{weight of dry gluten}}{weight\ of sample} \times 100 \qquad (7)$$

Determination of pasting properties

The pasting properties of wheat flour packed in different packaging materials were assessed using the Rapid Visco-Analyzer (Model: Anton Paar MCR 52) with a rheoplus software. About 3 g of sample was mixed with 25 ml of distilled water and the solution was dispersed properly. The initial temperature was set to 50^{o}C.The viscosity values were recorded as every 4 seconds as the temperature increased from 50^{o}C to 95^{o}C. Then the temperature was reduced to 50^{o}C again. The total running time of 24 minutes was used. Peak viscosity, pasting temperature, breakdown viscosity, final viscosity, setback viscosity, trough viscosity and peak time were measured. All the measurements were conducted in triplicate (15).

Statistical analysis

All the data were statistically analyzed using IBM SPSS software (version 20). The result was expressed as means ± standard deviation. General linear model (Univariate) and Tukey multiple range test, and least significant differences (LSD) at $p<0.05$ was performed to determine significant differences of the values of physical, functional, and rheological properties.

RESULTS AND DISCUSSION

Bulk density

The bulk density of wheat flour stored in the three different packaging materials are shown in Table 1. The initial bulk density ofwheat flour was measured as 0.541 g/ml.The highest bulk density was obtained inBP (0.818 g/ml), followed by PP (0.811 g/ml),and LDPE (0.777 g/ml)on 90th day of storage.Significant difference ($P < 0.05$) was recorded among the storage periods and there is not significant ($P >0.05$) between packaging materials.Bulk density increased when water absorption index and water solubility index increased(16).The lower bulk density indicates that less amount of the food samples will be packaged in a constant volume, resulting in more cost-effective packing (17). On the other hand, low bulk density, might be beneficial in the development of complementary foods (13).Low bulk density might be caused by loose structure of the starch (18).

Dispersibility

The feature of dispersibility defines flour's ability to separate from water molecules and demonstrates its hydrophobic interaction (19). Table 1 shows that the dispersibility of wheat flour samples packed in BP, PP, and LDPE materials at ambient temperature. There is a noticeable variations observed in flour samples during storage. The dispersibility of wheat flour was observed to be 62.73 as control. In the study, dispersibility of wheat flour for BP, PP and LDPE were found as 72.71 %, 71.67 %, and 72.56 %, respectively.The dispersibility of flours significantly increased with increasing storage period. The obtained results are agreed with the value of 71.67 to 74.33 % for teff flour (18).Similarly the dispersibility of rice starches ranges from 75.10 to 82.12 % are better than the breadfruit starch (40.66 %) (15).

Water absorption capacity

The amount of water available for gelatinization and the ability of flour to absorb water are determined by water absorption capacity. It is determined by the presence of hydrophilic groups that bind water molecules, and a high WAC results in improved gelatinization characteristics (5). The water absorption capacity (WAC) of wheat flour are shown in Figure. 1. Water absorption increased with the increase of storage period and WAC of wheat flour control sample (0th day) was found to be 0.77 %. Wheat flour packed in BP film has the highest water absorption capacity of 2.23 % (BP) while, least at 2.09 % (LDPE)and 2.14 % (PP), respectively.During the storage period, a significant changes was observed. Water molecules are easily taken in by hydrophilic proteins, therefore an increase in water absorption capability might be due to an increase in protein concentration.The breakdown of starch also helps flour hydration (20). High WAC can be attributed to thermal denaturation of protein in the sample (21). Increases in WAC have traditionally been linked to increased amylose leaching and solubility, as well as the degradation of starch crystalline structure. More hydrophilic components, such as polysaccharides, may be present in flours with high water absorption (13).

Swelling power, water absorption and solubility index

The swelling power (SP) of stored wheat flour samples is presented in Figure 2. The swelling power (SP) test was performed to determine the uptake of water by mainly undamaged granules in flour or starch at increased temperatures in the absence of shear forces (6). The swelling power (SP) of the stored wheat flour was found to be 3.010 (BP), 3.277 (PP), and 3.235 (LDPE) on 90th day of storage. The SP of control sample was found as 1.378. In the absence of shear pressures, the swelling power test evaluates the absorption of water by mostly undisrupted granules in wheat or starch at high temperatures (6). The swelling property of rice grains stored at 4°C observed lower values than the grains stored at 37 °C (22). Due to the hydrogen bonding and crystallinity of the molecule, starch granules are less soluble in water at low temperatures (40–50°C), resulting in the low swelling power seen in the samples (Tumwine et al., 2019). Swelling power indicates the ability of starch to absorb water and increase in size. During starch swelling, hydrogen bonds between starch molecules are replaced by hydrogen bonds with water. The water absorption and consequent swelling of the starch granule contribute to amylopectin-amylose phase separation and loss of crystalline, which in turn promotes the leaching of amyloseto the inter-granular space(24).

The water absorption index (WAI) of wheat flour sample is presented in Figure. 3. WAI of wheat flour found as 4.61for control. The values of the stored wheat flour for different packaging materials was found to be BP (12.43), PP(12.76), LDPE (12.64), respectively on 90th day of storage. There was an increasing trend in the water absorption index, which might be related to a greater amount of damaged starch (25).

The water solubility index (WSI) of stored wheat flour samples depicted in Figure. 3.WSI of the wheat flour were found 6.955 as control (0th day), during storage it was decreased that the SI of the stored wheat flour were depicted as BP (3.175), PP (2.845), and LDPE (2.720) percent, respectively.Amylose leaching is responsible for the majority of the solubility of starch-based products; higher solubility implies more leaching, whereas lower solubility indicates less leaching. The water solubility index is a measurement of the amount of soluble starch in flour. In addition to excess water, which indicates the amount of free molecules leached out of the starch granule (26).Torruco-Uco et al., (2019) investigated that, when increasing the temperature increases the solubility, this might be due to the weakening of connections between proteins and other components, such as lipids. For swelling power, water absorption and solubility index, there is no significant different ($p > 0.05$) among the packaging materials significant ($p < 0.05$) changes observed during storage periods.

Gluten content

To evaluate the quality of wheat flour, the gluten content must be determined and the results was reported in Table 1. The initial gluten content was depicted as 41.98 %. During 90 days of storage period, the gluten content of wheat flour were dropped to(3.97%) for BP, (8.53 %) for PP, and(9.66 %) for LDPE at 90th day of storage, respectively. Reduction in gluten content might be due to packaging materials and storage periods. The gluten content of wheat flour was significantly ($p < 0.05$) affected by storage at ambient temperature and storage period(28). Sujitha et al., (2018) investigated that the initial wet gluten content of wheat flour sample was found to be 39. 5%, during storage it was decreased in room temperature (38.1 %) as well as air conditioned (39.2 %), respectively. Keskin & Ozkaya, (2015) investigated that the gluten content of insect infested wheat flour samples was decreased due to gluten as brittle and disintegrated easily.

Determination of pasting properties

The pasting curves were from rapid viscoamylograph (RVA) was a determination of the viscosity of wheat flour suspension during the heating phase, which represents the molecular changes takes place in the starch granules. Pasting properties of wheat flour packed in different packaging materials were studied and its parameters are summarized in Table 2. Pasting profile of stored wheat flour are presented in Figure 4. The pasting temperatures of all samples ranges between49.81 to 64.95 °C and significant ($p \leq 0.05$) effect was observed in the stored wheat flour samples.The peak and final viscosity of wheat flour samples were increased from 1287 to 1548 cP and 1158 to 1485 during storage. Pasting temperature of the wheat flour was reported as 67.75°C.

During the process, the starch swells, get increased its size, disintegrate the molecules and the amylose leaches out form three dimensional structures and resulted in increased paste viscosity. The starch swells, expands in size, disintegrates the molecules, and the amylose leaches out to create three-dimensional structures, resulting in higher paste viscosity(31). The retrogradation of this paste characteristic is related to the presence of amylopectin, and it starts 20 °C lower than its gelatinization temperature (T_{gel}).The pasting temperature is refers to the temperature where the viscosity of starch begins to increase during the heating procedure and at higher pasting temperature the starch begins to swells and rupture. The higher pasting temperature was most likely caused by the increased water absorption capacity (32). Peak viscosity is linked to final product quality and also serves as a predictor of the viscous loads that will be entered during mixing (33). The rate of amylose exudation, granules swelling, amylose-lipid complex formation, and competition for free water between exudated amylose and remaining granules all impact trough viscosity (16).The distribution of amylopectin chains and the molecular size of amylose have a synergistic impact on the viscosity of starch pastes. Swelling power has been linked to wheat starch pasting properties as assessed by the RVA(7).

Table 1 Bulk density, dispersibility, and gluten content of wheat flour packed in different packaging material

Parameters	Packaging materials	Storage days						
		0	15	30	45	60	75	90
Bulk density (g/ml)	BP	0.541±0.021^{a,1}	0.591±0.003^{a,1,2}	0.605±0.010^{a,1,2}	0.635±0.059^{a,1,2}	0.683±0.012^{a,2}	0.660±0.018^{a,2}	0.818±0.023^{a,3}
	PP	0.541±0.021^{a,1}	0.572±0.023^{a,1,2}	0.589±0.003^{a,1,2}	0.611±0.005^{a,2,3}	0.651±0.023^{a,3}	0.713±0.016^{a,4}	0.811±0.005^{a,5}
	LDPE	0.541±0.021^{a,1}	0.575±0.025^{a,1,2}	0.584±0.006^{a,1,2}	0.604±0.015^{a,1,2}	0.641±0.021^{a,1,2}	0.660±0.047^{a,2}	0.777±0.04^{a,3}
Dispersibility (%)	BP	62.735±0.544^{a,1}	69.000±0.099^{a,2}	69.605±0.658^{b,2,3}	70.640±0.580^{a,b,3}	71.550±0.651^{a,b,4}	71.690±0.594^{a,4}	72.710±0.806^{a,5}
	PP	62.735±0.544^{a,1}	68.360±0.537^{a,3}	64.970±0.651^{a,2}	68.615±0.601^{a,3,4}	70.970±0.11^{a,4}	71.285±0.064^{a,4,5}	71.670±0.580^{a,5}
	LDPE	62.735±0.544^{a,1}	68.305±0.785^{a,2}	68.940±0.212^{b,2,3}	70.920±0.113^{b,3}	71.490±0.764^{b,3,4}	71.405±0.955^{a,4}	72.560±0.820^{a,5}
Gluten content (%)	BP	41.98±0.13^{a,7}	37.34±0.78^{b,6}	29.29±0.90^{a,5}	23.58±0.91^{a,4}	16.95±0.49^{a,3}	7.84±0.32^{a,2}	3.97±0.55^{a,1}
	PP	41.98±0.13^{a,6}	35.41±0.73^{a,5}	30.95±0.36^{a,b,4,5}	29.32±0.78^{b,4}	20.11±0.95^{b,3}	12.74±0.70^{b,2}	8.53±0.42^{b,1}
	LDPE	41.98±0.13^{a,6}	35.09±0.18^{a,5,6}	34.11±0.78^{b,,5}	31.12±0.29^{c,4}	22.22±0.49^{c,3}	14.27±0.58^{c,2}	9.66±0.69^{c,1}

All the values in table are represented Mean ± standard deviation form.
*Bulk density, dispersibility, and gluten content of BP (Bioplastics), PP (Polypropylene), and LDPE (Low density poly ethylene) packaging materials. Different letters and numbers indicates significant differences among the packaging materials and storage periods ($p<0.05$).

Table 2 Pasting properties of stored wheat flour samples in BP, PP, and LDPE packaging materials

Storage days	Packaging materials	Peak viscosity [cP]	Pasting temperature [°C]	Holding strength [cP]	Breakdown viscosity [cP]	Final viscosity [cP]	Setback from peak [cP]	Setback from trough [cP]
0th Day	BP	1287±31.88^{a,1}	49.55±0.14^{a,1}	288.4±24.12^{a,1}	587.9±33.41^{a,1}	1158±47.98^{a,1}	404.2±21.37^{a,1}	1094±53.27^{a,1}
	PP	1287±44.06^{a,1}	49.55±0.58^{a,1}	288.4±31.82^{a1}	587.9±27.57^{a,1}	1158±54.85^{a,1}	404.2±56.07^{a,1}	1094±51.76^{a,1}
	LDPE	1287±28.56^{a,1}	49.55±0.75^{a,1}	288.4±44.19^{a,1}	587.9±33.51^{a,1}	1158±24.47^{a,1}	404.2±45.92^{a,1}	1094±17.05^{a,1}
15th day	BP	1353±39.15^{b,2}	50.43±0.68^{b,3}	546.5±33.7^{b,3}	590±23.27^{b,2}	1237±24.98^{a,2}	528±37.55^{b2}	1178±23.90^{b,2}
	PP	1296±45.87^{a,1}	49.98±0.57^{a,1,2}	455.3±30.57^{a,b,2}	578±33.65^{a,1}	1598±38.59^{c,2}	498±52.48^{a,2}	1136±39.58^{a,b,2}
	LDPE	1668±35.23^{c,4}	50.12±0.32^{a,2}	437±23.19^{a,2}	597.6±25.49^{b,1}	1311±24.78^{b,2}	518.4±35.80^{b,2}	1116±22.40^{a,1,2}
30th day	BP	1457±32.65^{b,3}	50.39±0.35^{b,3}	424±17.01^{a,2}	665.2±43.48^{a,3}	1423±57.38^{a,3}	593.1±23.79^{b,3}	1258±30.98^{a,3}
	PP	1453±53.23^{b,2}	49.76±0.24^{a,1}	543±51.03^{b,3}	678±51.55^{a,b,2}	1546±24.89^{b,2}	597.3±53.07^{b,3,4}	1248±24.80^{a,3}
	LDPE	1390±43.48^{a,2,3}	49.98±0.66^{a,1}	518±48.24^{a,b,3}	686.6±42.14^{b,2}	1673±28.79^{c,3}	560.9±35.70^{a,2}	1587±39.85^{b,2}
45th day	BP	1833±51.39^{b,5}	50.01±0.76^{a,b,1,2}	590±69.39^{a,b,3,4}	893±22.44^{a,4}	1951±39.84^{b,4}	723.4±35.85^{c,5}	1732±24.74^{a,4}
	PP	1944±54.58^{c,4}	49.88±0.65^{a,1,2}	634.3±22.11^{b,4,5}	1030±40.23^{b,3}	1853±14.39^{a,3}	558.1±17.90^{a,3}	1867±88.93^{b,5}
	LDPE	1798±47.65^{a,5}	50.12±1.57^{b,2}	539±39.1^{a,3}	896±44.12^{a,3}	1865±43.87^{a,4}	612±64.79^{b2,3}	1744±30.23^{a,3}

60th day	BP	1480±23.69^{b,3}	52.37±0.52^{b,4}	551±30.58^{a,3}	1125±46.76^{a,5}	2187±47.98^{b,5}	634±53.78^{a,4}	1755±35.79^{b,5}
	PP	1543±33.76^{b,c,3}	50.05±0.42^{a,3}	614±50.08^{b,4}	1378±23.65^{c,4}	2050±21.47^{a,4}	665.5±13.49^{a,5}	1604±29.58^{a,4}
	LDPE	1345±45.68^{a,2}	50.11±0.74^{a,2}	624±42.94^{b,4}	1209±12.65^{b,4}	2557±58.43^{c,5}	763±21.57^{b,3}	1826±27.55^{c,4}
75th day	BP	1529±23.53^{a,4}	50.14±0.36^{a,2}	792.1±27.62^{b,5}	1241±32.48^{a,6}	2561±73.53^{b,6}	658±25.79^{b,4}	2273±24.05^{c,6}
	PP	1579±32.78^{b,3}	58.90±0.21^{b,4}	703.2±28.79^{a,6}	1309±37.58^{b,5}	2502±53.19^{b,5}	556±46.90^{a,4}	1996±37.57^{a,6}
	LDPE	1548±34.59^{a,b,3}	62.82±0.32^{c,3}	876±56.52^{c,5}	1485±24.10^{c,5}	2122±35.38^{a,6}	573.6±53.90^{a,2}	2102±28.94^{b,5}
90th day	BP	2176±20.44^{a,6}	59.23±0.45^{a,5}	1071±28.49^{b,6}	1629±24.78^{a,7}	2993±34.79^{a,7}	817.4±46.27^{a,5}	2447±32.89^{b,7}
	PP	2954±21.94^{c,5}	60.26±0.37^{b,5}	1187±42.50^{c,7}	1767±35.87^{b,6}	3511±34.87^{c,6}	958±35.90^{b,6}	2324±35.90^{a,b,7}
	LDPE	2565±45.67^{b,6}	62.93±0.48^{c,3}	936.5±45.09^{a,}	1628±25.36^{a,6}	3230±23.87^{b,7}	1032±40.79^{c,4}	2294±57.96^{a,6}

*BP-Bioplastics, PP -Polypropylene, LDPE - Low density polyethylene
Different letters and numbers indicates significant differences among the packaging materials and storage periods ($p<0.05$).

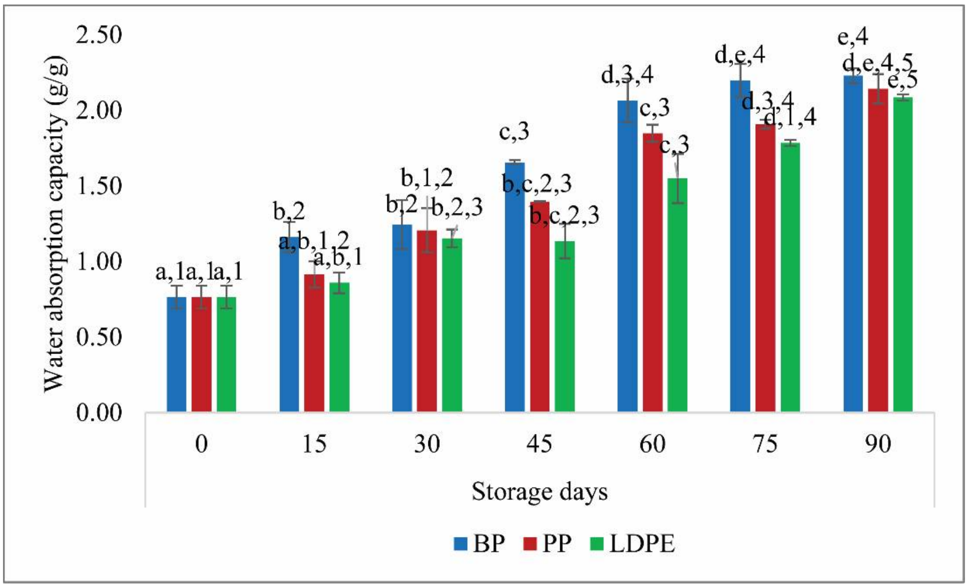

Figure 1. Water absorption capacity (WAC)of wheat flour during storage

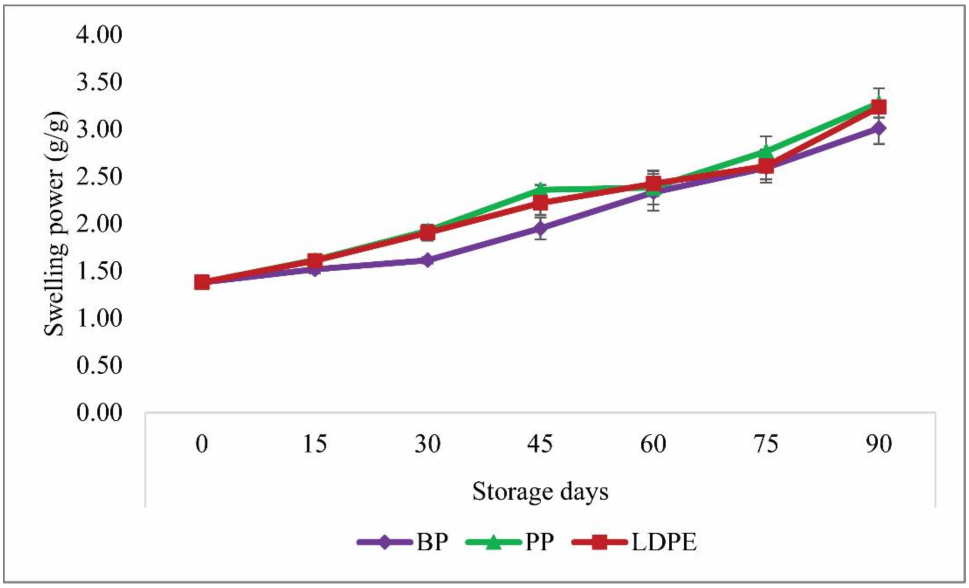

Figure 2. Swelling power of wheat flour packed in different packaging materials (BP, PP, and LDPE) during storage periods

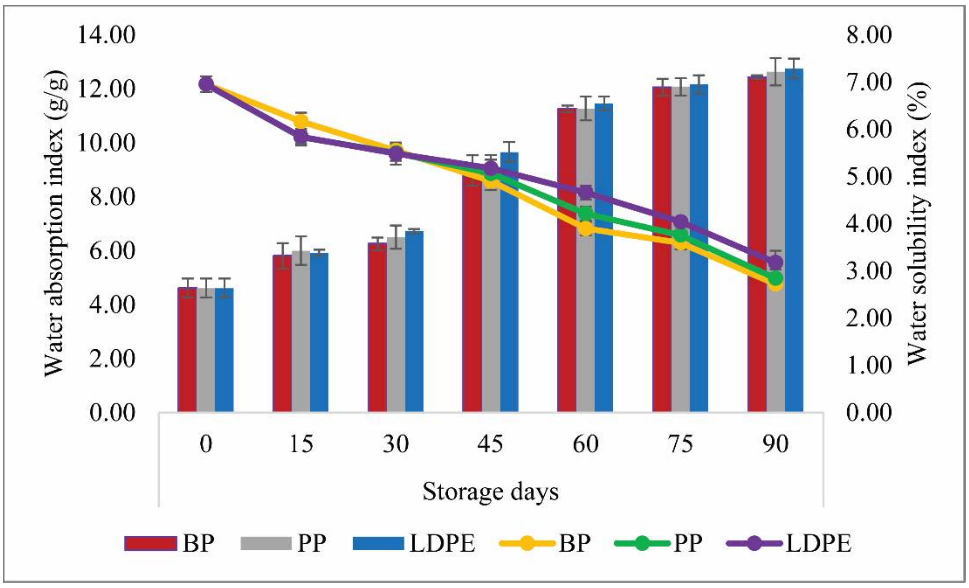

Figure 3. Water absorption and solubility index of wheat flour during storage

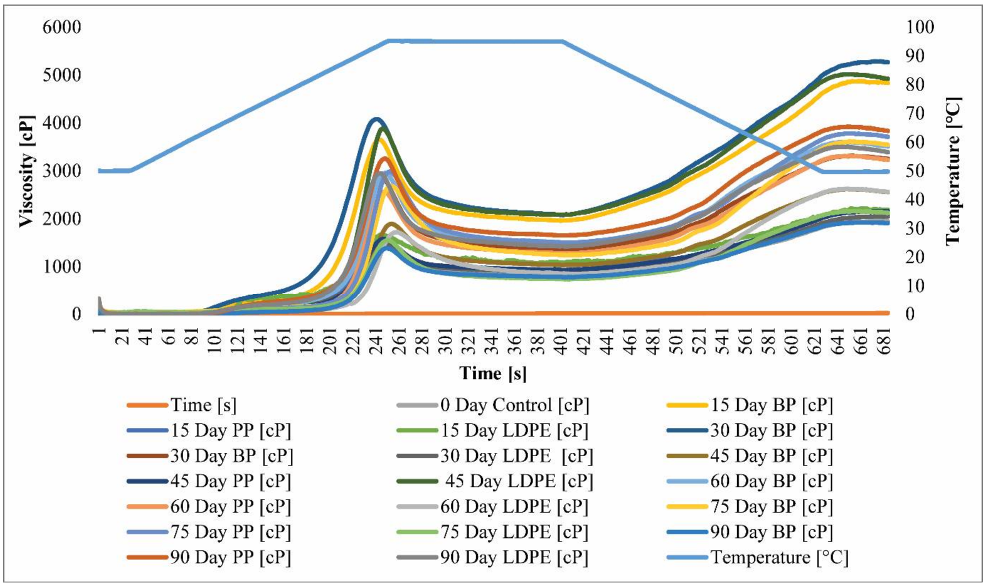

Figure 3. Water absorption and solubility index of wheat flour during storage

CONCLUSION

In this study, the effects of different packaging materials on the bulk density, dispersibility, WAC, swelling power, water absorption solubility index and pasting properties of stored wheat flour samples were evaluated. The bulk density, dispersibility, water absorption capacity, swelling power, water absorption index were increased and solubility index decreased with increased storage period. The water absorption capacity varied from 0.765 to 2.230 g/g. The gluten content of stored wheat flour was adversely affected by storage period.The lowest peak viscosity absorbed for control sample(1287 cP)and the highest(2565 cP) for LDPE packaging material on 90th day of storage.Among the packaging materials and storage period wheat flour quality was preserved better in BP (60 days), PP (75 days), and LDPE (90 days) respectively.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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