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Evaluation the Nutritional Value and Staling Rate of Toast Breads Fortified with Xanthan Gum and Potato Flour

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ABSTRACT

In this research, after conducting chemical tests on flour samples (moisture, ash, protein, fiber and pH), potato flour and xanthan gum were added to wheat four at levels 5, 10 and 15 percents and 0.5 and 1 percents, respectively, and subsequently production of toast bread in semi-industrial manner was started, Then the qualitative characteristics (Nutritional Value) of toast breads were measured and Staling rate of all samples was evaluated mechanically with the use of Instron machine. The results of evaluation of Nutritional Value of bread samples showed that the amount of moisture, protein, ash and fiber in breads containing of potato flour and xanthan were increasing in proportion to controlled bread (bread not containing potato flour and xanthan), in addition to the fact that application of 10 and 15 percent levels of potato flour and 1percent level of xanthan gum resulted in a better Nutritional Value in comparison with other levels. Also evaluation of bread samples after 24, 48 and 72 hours of baking showed that potato flour and xanthan gum had positive influences on breads freshness and P_1 treatment (5% potato flour and 0.5% xanthan) showing the highest tenderness and the lowest staling rate at all three time intervals. Mechanical analysis indicated that samples containing different levels of potato flour and 0.5% Xanthan (P_1, P_2 and P_3) are showing the lowest staling rate.

Keyword: Potato Flour, Xanthan Gum, Toast Bread, Instron Machine, Staling Rate.

1. INTRODUCTION

Bread is a mixture of whole grain flour, water or other liquids and certain compounds produced through stirring, mixing and baking until it is digested and absorbed in body [1]. Bread quality is influenced by different factors such as additives and improvers among which potato flour and hydrocolloids can be referred [2]. From among processed preparations of potato, potato flour is the oldest product which can be incorpo-

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rated into formulation of different food products [3]. Based on several studies addition of potato flour to formulation of wheat bread leads to improvement of bread quality, water retention capacity, freshness, flavor and fermentation process while enhancing nutritional value of bread and compensating for shortage of wheat proteins [4]. Also potato flour can replace a part of wheat flour consumed in biscuit preparing due to containing low fat, high fiber, some vitamins, minerals and an appropriate amount of high quality protein [5]. Note that potato flour and potato starch are two different products which should not be considered as the same. In fact potato flour is a dried baked product containing all potato compositions except its peel whereas potato starch is a product of high purity and devoid of other constituents. [4, 5] In terms of chemical composition, potato flour contains 77-79% carbohydrate. 9-11% protein, 4-4.5% ash, 1.17-1.18% crude fiber and 0.1-0.2% fat [6]. Regarding protein quality potato is comparable to certain animal proteins. For instance the amount of amino acid lysine present at potato is similar to animal proteins and comparable to whole egg [7].

Of other appropriate additives used broadly for bread preparing we can refer to gums or hydrocolloids. Presently in order to enhance water retention capacity, volume and viscoelastic properties of the obtained bread, some gums are used and even it is confirmed that these compounds can improve elasticity of potato starch. Xanthan is one of the most functional gums produced during fermentation by "Xanthomonas campestris". It is a kind of heteropolysaccharid composed of β-D (1→4) glocose links and lateral chains and found as a white powder soluble in hot and cold water [4, 8 and 9]. Willard & Englar (1961) stated that the amount of water absorbed into bread samples prepared from a mixture of wheat flour and potato flour had a direct relationship with the amount of potato flour in corporate into bread formulation [10]. Barker (1976) used dried baked potato flour for preparing bread and other bakery products and found that incorporation of potato flour at levels of 25% improved the end quality of cakes, cookies and pastries [10]. Singh et al. (2003) presented that potato flour containing a high percent of amylase enhanced water absorption and its solubility leading to improvement of starch inflation as well as its solubility [6]. Based on Collar et al. (1999) addition of xanthan gum to wheat bread dough resulted in enhanced dough resistance to stretch [11]. Lazaridou et al. (2007) investigated the effects of addition of different gums (pectin, CMC, agarose, xanthan and beta-glucan) at levels of 1 and 2% on dough properties and quality characteristics of gluten-free bread and found that xanthan had the highest effect on viscoelastic properties of dough and its stability. In addition an increase in gum concentration from 1% to 2% decreased volume of the obtained bread samples [12]. Pressinin et al. (2010) showed that incorporation of xanthan and polypropylene glico alginate at levels of 0.5, 1 and 1.5% into formulation of bread samples prepared from a mixture of rice flour and rye flour lead to improvement of dough resistance and storage life of bread as well as the structure of its crumb [9].

2. EXPERIMENTAL

2.1. Materials

Wheat flour with extraction degree of 68% (sahar Bread co.), potato flour (Shukufeh fam Co. Amol), Xanthan gum (Tellon Co. China), dried bakery yeast (Saccharomysis Cerivisiae) (Iran Mollas co.), salt (Hadieh vo.), sugar, water and oil were used in order to prepare bread. Table 1 show different treatments used in the present research.

2.2. Methods

2.2.1. Chemical assays of flour and bread samples

Chemical assays carried on wheat flour and potato flour at three replications included moisture (AACC, No. 44-16), ash (AACC, No. 08-01) protein (AACC, No. 46-12), fiber (AACC, No. 32-10) and pH (AACC, No. 02-52) [13].

2.2.2. Procedure of toast bread baking

In order to prepare toast bread initial ingredients such wheat flour, potato flour, xanthan gum, salt, the yeast Saccharomysis cerivisiae, sugar, water and liquid oil were purchased and weighted. Potato flour at different levels of 5, 10, 15% as well as xanthan gum at two levels of 0.5% and 1% were added to wheat flour followed by mixing at dough- making tank for 10 min.

Table 1: *The treatments were used in experiment.*

Test	Description
C	Control bread (no Potato flour and Xanthan gum)
P_1	Toast bread containing 5% Potato Flour and 0.5% Xanthan
P_2	Toast bread containing 10% Potato Flour and 0.5% Xanthan
P_3	Toast bread containing 15% Potato flour and 0.5% Xanthan
P_4	Toast bread containing 5% Potato Flour and 1% Xanthan
P_5	Toast bread containing 10% Potato Flour and 1% Xanthan
P_6	Toast bread containing 15% Potato Flour and 1% Xanthan

other powdery and dry materials were then added to the mixture. In this stage water was added and after thorough mixing with flour, a flexible mass of dough was formed. Initial rest of samples was done for 10 min. the dough was then scaled into 400 g portions, rounded and rested for another 10 min to undergo medial fermentation. Dough divisions were then fed into fermentation chamber for final fermentation at 30°C and 80% RH for 40 min followed by transferring to a rotary oven and baking for 45 min at 220- 230ºC [14].

2.2.3. Determination of staling rate of toast breads by mechanical method

Staling rate of bread samples was measured by Instron machine (M 350-10 CT, England). This experiment was done after 24, 48 and 72 hours of baking at three replications. In this regard bread samples were separately placed at plastic bags and stored at room temperature. 2 cm × 2 cm portions were then cut from the crumb to measure by instron. Force values (the amount of force exerted by upper jaw of instron) were regarded as to be equal to 40% of diameter of bread sample so that sample compressed to 8 mm. In addition speed of movement of upper jaw downward was set on 30 mm per minutes. In this assay a disk-shaped probe was used [13].

2.2.4. Statistical analysis

Data analysis was performed in a completely randomized design followed by Duncan's multiple range tests using MSTATC software.

3. RESULTS AND DISCUSSION

3.1. Results of chemical assays of flour samples

Table 2 shows quality characteristics of potato flour and wheat flour samples.

3.2. Results of chemical assays of bread samples

Table 3 indicates results obtained from mean comparison of quality characteristics of control toast sample and bread samples containing potato flour and xanthan gum.

In each column mean that at least one letter in common, according to Duncan's test is not significant at the 1% level. As one can see from Table 3 enrichment with potato flour enhanced moisture content of the obtained bread so that treatments containing 15% potato flour and 0.5% xanthan as well as treatment containing 15% potato flour and 1% xanthan had the highest moisture content and a significant difference with control treatment ($p<0.01$). It is attributed to high

Table 2: *Chemical properties of wheat flour and potato flour.*

Flour	Protein (%)	Ash (%)	Fiber (%)	Moisture (%)	pH
Wheat flour	9.5	0.39	0.107	11.73	5
Potato flour	10.49	3.19	1.36	6.04	6.1

Table 3: *Qualitative characteristics (Nutritional Value) of bread samples.*

Treatment	Protein (%)	Ash (%)	Fiber (%)	Moisture (%)
C	7.59^{e}	0.98^{e}	0.094^{a}	32.93^{d}
P_1	7.78^{d}	1.16^{d}	0.107^{a}	36.48^{c}
P_2	8.23^{b}	1.35^{b}	0.126^{a}	37.34^{b}
P_3	9.89^{a}	1.53^{a}	0.145^{a}	39.20^{a}
P_4	7.92^{c}	1.21^{c}	0.11^{a}	36.92^{c}
P_5	8.29^{b}	1.14^{b}	0.131^{a}	37.70^{b}
P_6	9.96^{a}	1.59^{a}	0.149^{a}	39.65^{a}

amount of starch present at potato flour and since water absorption into potato starch is high, an increase in the amount of potato flour and consequently starch amount leads to increase in bread moisture. These results are in line with the findings of Neuman [10]. Furthermore moisture content increased with xanthan level so that samples containing 1% xanthan had more moisture content than samples containing 0.5% of this gum. These results confirm those of Rusell et al. who observed that enhanced water activity and consequent moisture content of bread samples containing hydrocolloids were due to high water retention capacity of hydrocolloids [15].

Based on Table 3 protein content of the obtained bread was increased with potato flour level. Misra and Kulshreshtha also found similar results. They reported that protein content of biscuits containing potato flour was increased compared with control sample [3].

Table 3 shows that potato flour increased ash content of bread samples, it was due to high amount of minerals present at potato flour leading to enhancement of ash content compared to control sample. Singh et al. also found similar results [6]. On the other hand ash content was increased with gum level so that samples containing 1% xanthan gum had higher ash content than samples containing 0.5% of this gum ($p<0.01$). Results obtained in this study were in accordance with findings of Ghodke et al. who reported that ash content of gum-containing samples was increased compared to control bread sample [16].

In addition enrichment with potato flour and xanthan gum enhanced fiber content of bread samples ($p<0.01$). Based on results obtained in this research addition of different levels of potato flour and xanthan gum to formulation of toast bread led to improvement of all quality characteristics of the obtained bread so that all samples containing potato flour and xanthan gum had higher moisture, protein and ash contents compared to control samples with two treatments containing 15% potato flour being the best treatments in terms of quality characteristics. In other words incorporation of the said substances into formulation of wheat bread while enhancing water retention capacity and consequently crumb quality leads to improvement of nutritional value of bread and compensation for shortage of wheat proteins. Thus they can be represented as one of the best additives in preparing bread and other bakery products such as cakes and pastries. Results of determination of staling rate of toast breads by mechanical method Table 4 presents Comparison of staling test of toast bread samples.

In each column mean that at least one letter in common, according to Duncan's test is not significant at the 1% level. Table 4 indicates results obtained from assay measuring Staling rate of samples after 1, 2 and 3 days of baking. As one can see from this Table after 24 hours of baking P6 and control treatments showed the highest rate of staling respectively ($p<0.01$). Therefore treatments containing 5 and 10% potato flour and 0.5% Xanthan (P1, P2) had higher tenderness and lower staling than other treatments since potato flour kept the bread moist for a longer time due to containing a high amount of starch especially amilopectin which had a longer lateral chain compared to amilopectin present at grains [10].

Furthermore, staling rate of samples containing

Table 4: *Comparison of staling test of toast bread samples (N).*

Treatment	Staling rate after 24 hours	Staling rate after 48 hours	Staling rate after 72 hours
C	5.278^{f}	7.307^{d}	7.755^{d}
P_1	1.571^{a}	2.357^{a}	3.352^{a}
P_2	3.951^{b}	6.573^{c}	7.279^{c}
P_3	4.21^{d}	5.701^{b}	6.004^{b}
P_4	4.053^{c}	5.711^{b}	9.336^{e}
P_5	4.490^{e}	9.598^{e}	10.10^{f}
P_6	6.336^{g}	10.62^{f}	15.49^{e}

0.5% xanthan was lower than that of samples containing 1% of this gum. Similar results were obtained by Lazaridou et al., (2007) who reported that addition of 1% xanthan led to enhanced toughness of bread samples [12]. As one can see from Table 4, after 24 hours of baking the highest staling rate was related to P6-treatment. The reason is that simultaneous presence of the maximum amounts of potato flour (15%) and xanthan (1%) led to aggregation of excess moisture in bread texture which is regarded as a cause of staling. The more the moisture of bread after exit from oven, the later the bread will become stale [1]. There are different opinions on mechanisms and effects of gums on bread texture. On one hand it is believed that moisture removed by thickening factors will be released during baking process and gelatinized with starch, On the other hand it has been confirmed that hydrocolloid substances compete with starch for water thus reducing water absorption by starch [15].

After 48 hours of baking P6 treatment showed the highest toughness (a significant difference with other treatments) and P1 showed the lowest ($P<0.01$). This holds true for bread samples investigated after 72 hours of baking.

4. CONCLUSIONS

Assessment of quality characteristics of samples showed that all bread samples enriched with potato flour and xanthan gum had more protein, moisture, ash and fiber contents than control bread and levels of 10 and 15% potato flour along with 1% xanthan resulting in the best quality. Although none of these samples contained all positive effects, samples containing 5% potato flour and 0.5% gum (P1) gained higher scores than other samples in terms of staling rate. Also staling rate of the most treatments was lower than that of control sample. In conclusion treatments containing different amounts of potato flour and 0.5% xanthan had the best staling properties. moreover since performance per hectare of potato is as two or three more than grains, prevention from use of wheat instead of products such as starch and its replacement for potato starch as well as incorporation of potato flour into bread formulation can have a basic role in development of integrated industries and reduction of agricultural wastage conclusion.

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