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Effect of hydroxy propyl methyl cellulose gum on organoleptic properties and staling rate of gluten free baguette

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ABSTRACT

Bakery products that is made from wheat flour consumes widely in the whole world. Gluten protein has an effect in paste adherence, Rheology properties, sponge tissue stability and porosity of food such as bread and baked products. But according to this fact that celiac patients has lack of gluten protein resistance and mentioned illness causes serious damage to their small intestinal mucosa and its results are absorption of nutrients reduction, weight loss, diarrhea, anemia, abdominal bloating, depression. Therefore, the aim of this study is improving the performance of bread production from gluten-free cereals (corn flour and potato flour) and effect survey of hydroxy propyl methyl cellulose gum (different levels of 0.25, 0.5, 0.75 and 1 weight percentage - weight based on consumed flour) on the quality characteristics of gluten free baguette. At first, various chemical tests such as moisture measuring, ash, protein, fiber, pH on corn flour and potato flour samples according AACC International standard with three replicates were performed.Then evaluation of the organoleptic characteristics of baguette with the AACC standard was performed.In addition to measure the staling of bread production samples Instron machine with AACC standard method was used. Meanwhile, data from the statistical analysis by completely randomized design method, Duncan's test and MSTATC software at level of $\alpha \leq 1\%$ was done. Chemical tests results showed that the used flour for gluten-free baguette production was useful. Besides, the results of the sensory tests by Panelists showed that in the most organoleptic characteristics (volume, crust color, smoothing the back, Prosily and granule , aroma , smell and texture) samples containing 1% HPMC gum (H_4 treatment) is the best organoleptic characteristics treatment.Furthermore, the results of the staling rate tests with the Instron machine at intervals of 24, 48 and 72 hours after baking revealed that the two periods of 24 and 48 hours after baking, control treatment (without gum) has the highest staling rate and H_4 treatment (including 1% gum) and then H3 treatments (containing 0.75% gum) and H_2 (with 0.5% gum) has the least staling and 72 hours after H_2 and H_4 treatment had the lowest staling level and control had the highest staling level.

Keywords: Hydroxy Propyl Methyl Cellulose Gum, organoleptic, staling , Gluten Free Bread

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INTRODUCTION

Cereals is the first crop that human is used as food and today in the most countries in the world, providing the greatest amount of calories, protein, fiber, vitamins and minerals to man. Among the cereals, wheat because of its nutritional and particular technological properties have been concern by the most people and the most widely used products are made from this valuable nutrient is bread [15]. Doubtless wheat flour in bread production is the best choice, due to gluten, dough processing conditions, fermented dough, dough quality and especially the bread bulk the result is improved [3].Consumption of gluten causes small intestine inflammation in some patients with celiac that results in poor absorption of essential substances such as iron, calcium and fat-soluble vitamins [10]. Celiac disease is a chronic intestinal disorder that with mal-absorption of nutrients in the small intestine after ingestion of food containing gluten,

including wheat, barley, oats and rye and it means that the patient cannot take food containing gluten protein. This disease is recognized with malfunction in immune responses, indigestion and poor absorption of nutrients, vitamins and micro-analysis of the intestinal [7]. Another complication of celiac disease can be mentioned as osteoporosis, neurological problems, Epilepsy and depression [7].The main treatment for celiac disease is gluten-free diet throughout the lifetime of the patient. It should also cereals such as wheat, barley and rye be eliminated from their diet and grains such as corn, rice and other grains flour that are gluten-free be replaced [6 , 13]. Gluten-free breads are dietary breads that are essential for patients with celiac disease, especially children that in their preparation in rather than wheat flour, rye, barley, and oats is used from starch (corn, potato and rice), and other cereals flour (millet, cassava, maize and black wheat) that are gluten-free is used, along with additive such as gum, enzymes, proteins (soy, eggs and milk) [10]. Corn flour is a good substitute for wheat flour in bread baking products that has high nutritional value and it is gluten-free suitable for people with celiac disease [2]. Today, corn products have numerous applications, for example corn flour in the production bread, biscuits, pasta, corn starch powder, snacks and cereals, starch in the production of corn syrup [3]. In terms of nutritional value, corn flour contains high amounts of minerals such as potassium, phosphorus, zinc, calcium, iron and certain vitamins such as thiamin, niacin, E and B_6 and zein protein [18].Corn flour contains about 83% starch, 6.6% protein, 3 - 4% cellulose and other polysaccharides, 1% insoluble fiber, 0.5% soluble fiber and about 5% of non-protein elements that are incompatible with starch [11]. One of the benefits of products made from corn flour is their tenderness that is probably related to the structure of starch, zein protein, and lack of adhesion between starch matrix and mentioned protein [11]. Potato flour is one of the best alternatives to wheat flour in bread production and they are match. Today, not only in bread production but also in the production of Products such as potato crackers, some pastries, cakes, cookies, donuts and sauces is used [9].Adding potato flour to formulations improves the quality, water holding capacity increase, freshness Preservation, pleasant taste, fermentation process improvement and increasing nutritional value [9].In terms of chemical composition of potato flour has an average of 77-79% carbohydrates , 9-11% protein, and 4.5% ash , 1.11-1.17% crude fiber, 0.1-0.2% fat, amounts of potassium, magnesium, phosphorus, vitamin C, vitamin B_6 , antioxidants and dietary fibers. In addition, the protein quality compared with some animal protein (like egg protein) is good and it is rich with essential amino acids such as lysine [14, 19].Hydrocolloids are bunch of additives that are widely used in the food industry and are generally known as resins. Hydrocolloids due to having favorable impact on food acceptability system usually are added to containing starch and gluten-free products [8].Gums overall effects on wheat bread and gluten free bread certainly depend on gum source, chemical structure, method of extraction, chemical modification and their use in the formulation of gluten-free bread dough and interact with other compounds of wheat and gluten free bread. Hydrocolloids in gluten-free bread formulations act as structural polymer components and in water-swollen compose a structural of gluten network equivalent in wheat dough, and therefore provide gluten viscoelastic properties in the wheat dough. [12]. One of the most widely used gum in food and bakery is hydroxy propyl methyl cellulose gum which is derived from cellulose [4, 16]. Studies have shown that the use of HPMC in bakery products delays hardening of bread tissue and degrading amylopectin and also against reduction volume of the dough protects the product [17].Rosell and Gujral (2004) With survey and report of HPMC gum effect on rice bread quality has been cleared that with decreased consumption of HPMC, resistance of dough will decrease and in the presence of it beside of increasing mentioned feature, it will increases the rate of water absorption of the dough. Rosell (2005) presented a study that HPMC has a role in delaying amylopectin retrogradasion and preventing staling of bakery products, also Schober et al (2008) surveyed the effects of adding hydroxy propyl methyl cellulose in the properties of corn starch and zein mixture bread and reported that hydroxyl propyl methyl cellulose significantly improve the gases stability in dough and volume utility.

MATERIALS AND METHODS

At first, the raw material for baguette bread baking process, including corn flour (corn flour Co.), potato flour (Bartar Co.), HPMC gum (Petro Pars Novin Co.), yeast (Iran molasses Co.), salt (Hedie Co.) and polyethylene bags used for packaging bread baguette was prepared. Studied population consisted of equal mixing of corn flour and potato flour along with 0.25, 0.5, 0.75 and 1% hydroxy propyl methyl cellulose gum for gluten-free baguette production. In all tests, the control sample (equal mixture of corn flour and potato flour with no gum) with C code and samples with 0.25 , 0.5, 0.75 and 1% hydroxy propyl methyl cellulose gum, respectively were identified with H_1, H_2 , H_3 and H_4 code. Various chemical tests to measure moisture content (AACC , No. 44-16), ash (AACC, No. 01-08), protein (AACC, No. 46-12), fiber (AACC No. 32 -10) and pH (AACC, No. 2-52) on samples of corn flour and potato flour with three replications was conducted. In order to evaluate the organoleptic characteristics of baguette, for the bread characteristics analysis five senses was used. Criteria were the practice, opinion and the personal interest of trained specialist's persons (Panelists) in the product. In this study, the bread samples after cooling, was coded and by 10 trained raters evaluated. Assessment on the first day of baking was based on the bread characteristics (volume, crust color, smoothing the back, Porosity and granule, aroma, smell and texture) that any of them had special rating with its importance. Also, in order to assess the texture or staling rate of bread were used from Instron machine and AACC method with No. 74-09. This test has been done in intervals of 24, 48 and 72 hours after baking bread.

Statistical analysis

In order to analyze the data obtained from the experiment a completely randomized design with three replications was used and means comparison was done with Duncan's multiple range test and MSTATC software at the levels of $\alpha \leq 1$ %.

RESULTS AND DISCUSSION

The test results of the chemical characteristics of potato flour and corn flour consumption is presented in Table 1. Also in tables 2 and 3, respectively, the results of organoleptic test and the results of staling rate evaluation of gluten-free baguette samples has been mentioned in table 4.

Table 1 - Results of the chemical characteristics test of potato flour and corn flour used in the production of gluten-free baguette

Material	Moisture %	Ash %	Protein %	Fiber %	Ph
Potato flour	6.54	2.23	8.72	5.98	5
Corn flour	12.25	0.55	6.68	1.54	5.3

Table 2 - Test results of the external organoleptic properties of gluten-free baguette

Treatment	Volume	Crust color	Back Uniformity
H_1	7 ± 0.39 ab	6.33 ± 0.37 b	2.66 ± 0.3 a
H_2	8 ± 0.39 a	6.33 ± 0.37 b	2.33 ± 0.3 a
H_3	8 ± 0.39 a	6.33 ± 0.37 b	2.33 ± 0.3 a
H_4	8.33 ± 0.39 a	8 ± 0.37 a	2.66 ± 0.3 a
C	6 ± 0.39 b	6 ± 0.37 b	2 ± 0.3 a

In each column, means that at least one common letter are not significantly different according to Duncan's test at level 1%

Table 3 - Test results of the internal organoleptic properties of gluten-free baguette

Treatment	Porosity and granul	Aroma and smell	Tissue
H_1	7.33 ± 0.21 b	7.66 ± 0.49 b	11.33 ± 0.52 a
H_2	7 ± 0.21 b	8.33 ± 0.49 a	11 ± 0.52 a
H_3	8 ± 0.21 a	9 ± 0.49 a	11 ± 0.52 a
H_4	8 ± 0.21 a	9 ± 0.49 a	11.67 ± 0.52 a
C	6.33 ± 0.21 c	8 ± 0.49 b	10.67 ± 0.52 b

In each column, means that at least one common letter are not significantly different according to Duncan's test at level 1%

Table 4 – Test results of the staling test in gluten-free baguette samples (N)

Time(h)	H_4	H_3	H_2	H_1	C
24	7.4 ± 0.47a	8.4 ± 0.47a	8.94 ± 0.47a	18.45 ± 0.47b	23.68 ± 0.47c
48	8.363 ± 0.47a	9.706 ± 0.47a	10.67 ± 0.47a	19.02 ± 0.47b	26.34 ± 0.47c
72	15 ± 0.18a	15.22 ± 0.18a	13.69 ± 0.18a	21.31 ± 0.18b	28.31 ± 0.18c

In each column, means that at least one common letter are not significantly different according to Duncan's test at level 1

Evaluation of the flours chemical tests results

Table 1 results of chemical tests showed that corn flour and potato flour were suitable for the production of gluten-free baguette.

Organoleptic evaluation of external characteristics of gluten-free baguette

Evaluation of volume of gluten-free baguette

According to the comparison results of organoleptic evaluation mean baguette samples volume was determined according to Table 2 which the addition of HPMC gum increase the apparent size of baguette gumed samples compared to the control treatment (C) also the H_4 treatment has the highest volume and control samples had the lowest rates.

Also, no significant differences were found between treatments containing gum but among all of them (except for H_1 treatment) with control (without gum), the difference was significant ($P \leq 0.01$). Reason of appearance volume incensement of baguette is because of gum hydrophilic properties that due to the incensement of viscosity in the gas storage in dough were effective. Curic in 2007 reported adding the gum was effective in increasing bread volume and also Rocell et al (2001) reported the addition of HPMC gum on toast bread volume is effective[16].

Evaluation of crust color of gluten-free baguette

According to the results of organoleptic evaluation mean comparison of baguette samples color are shown in table 2 that addition of HPMC gum increases the rate of color of baguette samples containing gum than the control treatment, while the H_4 treatment has the highest color rate (with a significant difference with other treatments) and control

samples has the lowest that attributes ($P \leq 0.01$) The reason of color improvement in baguette samples containing gum related to increscent of browning color reaction is caused by the addition of gums [15]. Lazaridou in 2007 reported adding gum have desired effect on the color of bread crust.Gallagher and Gormley (2002) reported gluten free breads usually has lighter skin color than wheat bread but the addition of hydrocolloids with impact on the water distribution increases glycozylamin and finally was effective on the intensity of the mylard brownish reaction.

Evaluation of the back uniformity of gluten-free baguette

According to the results of organoleptic evaluation mean comparison back uniformity of baguette samples back was determined in table 2 that the addition of HPMC gum increased the smoothing rate of samples back the baguette with gum in comparison with the control sample. However statistically wasn`t observed significant difference between treatments. While the H_4 treatment has the highest back uniformity rating and control treatment has the lowest amount of it ($P \leq 0.01$)

The reason of back uniformity quantity rate increase in breads containing gum is used gum structure. However, its effect on the trait is not significant.

Moore and et al., (2006) reported that the addition of HPMC gum is effective in improving of the back uniformity characteristic in gluten free breads.

Organoleptic evaluation of gluten-free baguette internal properties

Evaluation of porosity and granule of gluten-free baguette

According to the results of organoleptic evaluation mean comparison, porosity and granul status of the baguette samples in table 3, it was shown that addition of HPMC gum increase the quantity rate of porosity and granul characteristic of baguette samples with gum, while H_3 and H_4 treatment has the highest rate of mentioned features and control treatment has the lowest rate. On the other hand, there wasn`t no significant differences between treatments containing gum with each other except H_2 treatment ($P \leq 0.01$). The reason of the baguette porosity increase containing gum is due to HPMC gum ability to maintain carbon dioxide gas and is volume increase of produced bread and also the gum due to absorption of water prevent bread tissue from the dryness that is consistent with the results of the Mezaize study in 2003 that gum increase will cause the porosity increases in the production of gluten-free breads.

Evaluation of Aroma and Smell gluten-free baguette

According to the comparison results of organoleptic evaluation mean aroma and smell of baguette samples was determined according to table 3 that the addition of HPMC gum increase the quantity rate of aroma and smell gum containing baguette samples except H_1 treatment next to control treatment, however, there wasn`t statistically significant difference between all treatments containing gum (except H_1) Meanwhile, H_4 and H_3 treatments has the highest quality and H_1 treatment and then control has the lowest quality ($P \leq 0.01$). Bread aroma and smell attribute in bread is dependent on reaction of caramelisation and mylard, and then aroma and smell rating in the breads that took place browning reactions in them is increased and because gums are effective in mylard brownish reactions increase, so It has the desired effect on the scent of bread. The results of the survey with results of Rocell in 2001 is match that reported adding gum in bread production, has a favorable impact on the fragrance perfume.

Evaluation of tissue baguette gluten-free

According to the comparison results of organoleptic evaluation mean the tissue of baguette samples were determined in table 3 that adding HPMC gum bread increase quantitative trait scores of baguette samples tissue containing gum compared to the control treatment, while the treatment of H_4 and then H_1 has the highest quality and control treatment has the lowest quality. However, statistically there wasn`t significant differences in mentioned attribute and between treatments containing gum ($P \leq 0.01$). Gums increase decrease stiffness, improve considerably the texture of soft bread and it`s because of hydrocolloids interactions with water and water distribution reduction during baking and maintenance. The results are consistent with Mezaize and associates reports in 2009 that said adding hydrocolloids in gluten-free bread formulation produces softer bread core. Also Gallagher in 2003 stated that the addition of gums have the desired effect on tissue characteristics and reduce the dryness of gluten-free bread [14 ,19]. Gambus et al., introduced in 2007 that adding the xanthan gum to corn starch and potato starch, mixture reduce stiffness of bread core. Lazaridou et al. in 2007 showed that the addition of hydrocolloids in high dosage increase bread elasticity level next to control.

Results evaluation of staling rete of gluten-free bread samples by Instron

According to the comparison results of staling rate evaluation mean with machinery method of baguette samples was determined as in table 4 that adding the HPMC gum in reducing staling in all three periods of 24, 48 and 72 hours after baking the baguette containing gum compared the control treatment had an impact, while at 24 and 48 hour periods H_4 and H_3 treatment, respectively, had a the lowest staling and control had the most. Also among all treatments that

contains gum with control treatment (without gum), there was a significant difference ($P \leq 0.01$)

According to the results of table 4 , determined that adding HPMC gum during the three days after baking baguette is effective in firmness reduction of gum contained bread compare to control treatment. Besides 72 hours after baking, H_2 and H_4 treatment had the lowest staling and control had the highest value, although there wasn`t significant differences between treatments containing gum, except $H_1$ ($P \leq 0.01$). Overall, in all three periods of 24, 48 and 72 hours after backing, statistically wasn`t observed significant differences in staling rate of gum contained treatments (except H_1). The reason of staling reduction in sample containing HPMC was increase of the bread elasticity compared to the control bread. besides, with increasing levels of mentioned gum the staling rate of produced bread has been decreased[17]. Since core of bread containing resin compared to the control bread was softer that the results with Mezaize research results in 2009 and also Cambus and associations in 2007 was consistent and they reported that use of various gums, especially in the levels of 1% has an effect in water absorption increase, soft tissue improvement and of postponing staleness. Rosell in 2005 and Gambus in 2007 reported usage of HPMC gum in production of gluten-free toast bread reduce bread staleness.

CONCLUSION

The results of chemical tests on corn flour and potato flour were shown that the used flour is suitable for the production of gluten-free baguette. The results of organoleptic features evaluation were shown produced baguette samples by panlysts that was evaluated in all sensory attributes, sample containing HPMC gum compared to a control treatment were more favorable. Between containing gum samples, sample that contains 1% HPMC gum in most traits were introduced the best treatment in terms of organoleptic characteristics.

The results of staling test using a machine by Instron device at intervals of 24, 48 and 72 hours after backing revealed that in the two periods of 24 and 48 hours after backing, control treatment has the most of staleness level and H_4 treatments and then H_3 and H_2 treatments have the least staling and after 72 hours H_2 treatment and then H_4 had the lowest staling. However, wasn`t observed any significant difference between containing gum treatments except H_1 .

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