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Impact of Cress Seed and Basil Gum and HPMC on Physicochemical and Textural Properties of Gluten-Free Bread

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ABSTRACT

Gluten is a structural protein for bakery products and its lack causes undesirable changes in the texture, color, and porosity of these products. Therefore, the use of gluten alternatives such as hydrocolloids, enzymes, and proteins, are essential in providing these products. The aim of this research was to evaluate the properties of gluten-free bread (physicochemical properties such as specific volume and porosity, stiffness, extensibility, and color parameter, as well as sensory properties) in the presence of 0, 0.5, 1, and 1.5% concentrations of gums including Cress seed gum (C) and Basil gum (B) compared to Hydroxypropyl Methylcellulose (HPMC) (H). The results indicated that adding gums to bread decreased stiffness and color parameters and increased specific volume, extensibility, and sensory properties. Based on the comparison between C, B and HPMC, basil gum could improve volume, porosity, and sensory score more than C and H. Also, the HPMC was more effective on the color parameter of gluten-free bread. Based on the results, addition of basil gum to the gluten-free bread recipe could improve the crumb texture, specific volume, sensory properties, as well as overall quality of the product. Basil gum as a novel gum increased water absorption, texture, and the best results were obtained in 1% basil gum. The results of bread quality parameters indicated $C_0B_1H_0$ had high specific volume and porosity. Therefore, basil seed gum can be a novel and useful gluten substitute for gluten-free bread baking purposes.

Keywords: Bread quality, Gluten sensitivity, Hydroxypropyl methylcellulose, Native gums.

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INTRODUCTION

Celiac disease is a disorder induced by gluten intolerance triggered by the ingestion of gluten, a protein found in some cereals, and its only treatment is the complete avoidance of this protein and observance to a gluten-free diet (Bascuñán *et al.*, 2017; Chishty and Singh, 2016).

Production of gluten-free food is a major technological challenge. Hence, breads based solely on gluten-free flours are usually characterized by significantly lower volumes and a firmer crumb when compared to wheat counterparts (Hager and Arendt, 2013). To solve this problem, hydrocolloids are used into gluten-free formulations. To this aim, various types of native hydrocolloids have been used in food industry such as cress seed, Qodumeh Shirazi, basil seed and Marve (Farahmandfar *et al.*, 2017; Razavi *et al.*, 2011).

Basil is native to tropical regions from central Africa to Southeast Asia. Basil, (*Ocimum Basilicum* L. family Lamiaceae), grows in Iran and is used as a seasoning and pharmaceutical (Naghibi *et al.*, 2005). Basil seed gum compared with commercial hydrocolloids like pectin, carrageenan, curdlan and carboxymethyl cellulose may provide foods with better mouth feel characteristics due to its unique gelling

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property (Bai *et al.*, 2019; Naji-Tabasi *et al.*, 2016). Basil seed consist of a hetero polysaccharide structure including glucomannan, xylan, and glucan (Hejrani *et al.*, 2019).

Cress seed *(Lepidium sativum)* is an annual herb and belongs to the Brassicaceae family. Cress seed gum is cultivated in Iran, North America, India, North America and Europe (Karazhiyan *et al.*, 2009; Razmkhah *et al.*, 2016). Cress Seed Gum (CSG) consists of L-rhamnose, L-arabinose, D-galactose, and D-xylose. CSG contains a noticeable amount of D-galacturonic acid and D-glucuronic acid, which have polyelectrolyte moiety and can have healthpromoting (Abbasi, 2017; Behrouzian *et al.*, 2014).

HPMC, a family of cellulose ethers, is obtained by the addition of methyl and hydroxypropyl groups to the cellulose chain. HPMC is widely applied as food emulsion stabilizer (Li *et al.*, 2013; Sarkar and Walker, 1995). HPMC is used as an additive in bakery products due to its high water holding capacity to improve product texture.

Basil seed gum, Cress seed gum and Quince seed gum have been added to whipped cream to improve the quality of the whipped cream (Farahmandfar *et al.*, 2017).

Basil and Balangu gums are added to Barbari bread to improve the volume, porosity, and sensory characteristics of the part baked frozen Barbari bread (Hejrani *et al.*, 2019).

Lepidium sativum seed and guar gum are added to rice-wheat bread and cause the increasing storage time and higher score for overall acceptability of the composite rice-wheat bread (Sahraiyan *et al.*, 2013).

Research has been done on the use of native and natural hydrocolloids in various food products such as bread, which is a basic commodity used by people around the world.

The physicochemical, functional, textural and bioactivities attributes of cress seed extractives indicate a potential for their use as novel food hydrocolloid, pharmaceutical excipient and herbal medicine sources (Behrouzian *et al.*, 2014).

CSG gel showed elastic, adhesiveness and cohesiveness properties, which could maintain product integrity during refrigeration operations and reduces moisture loss throughout the product shelf life and maintain maximum flavor, texture, and color (Naji and Razavi, 2014).

Hydroxypropyl methylcellulose is a suitable hydrocolloid to improve the texture and specific volume of gluten-free breads (Hager and Arendt, 2013; Kim *et al.*, 2015; Kim and Yokoyama, 2011; Sabanis and Tzia, 2011).

HPMC was used as an additive in bakery products due to its high water holding capacity and improve product texture (Bárcenas and Rosell, 2006).

HPMC has been used as an improver in wheat bread, yielding softer crumb, enhanced sensory characteristics and higher specific volume (Collar *et al.*, 1999; Committee, 2000; Rosell *et al.*, 2001). Cookies formulated from fresh okara using starch, soy flour and hydroxylpropyl methylcellulose had high quality and nutritional value and reduced the water activity, which increased shelf life and hardness and improved crispiness (Park *et al.*, 2015). Rosell *et al.* (2001) found better bread volume and improved volume when 0.5% HPMC was added to wheat flour (Rosell *et al.*, 2001).

HPMC proved useful in reducing diffusion and loss of water from bread crumb, and in limiting the interactions among starch and protein macromolecules, resulting in a softer gluten-free bread crumb and in slower staling kinetics during storage (Mariotti *et al.*, 2013).

HPMC was added to gluten-free breads based on rice, maize, teff and buckwheat and reduced crumb hardness as well as HPMC, had a positive linear effect on volume of teff and maize breads and a negative linear effect on this parameter in rice breads (Hager and Arendt, 2013).

Studies on the use of functional ingredients to improve quality and

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acceptability of composite bread are very rare, so, the aim of this study was to assess how addition of basil seed gum and cress seed gum and HPMC affect the physicochemical and textural properties and quality of gluten-free bread from composite quinoa, grass pea and chestnut flours.

MATERIALS AND METHODS

Quinoa flour with 10.34% moisture, 1.58% ash, 16.12% protein, 7.08% lipid and 6.12% fiber was procured from Razavi Factory, Mashhad, Iran. Grass Pea flour with 10.16% moisture, 2.84% ash, 11.07% protein, 0.93% lipid and 4.5% fiber was obtained from the local market. Chestnut flour with 12.56% moisture, 2.06% ash, 5.09% protein, 3.84% lipid and 9.26% fiber was procured from Molino Zanone Farina di Castagne, Italy (Malltina Amazon).

Quinoa flour was mixed with grass pea and chestnut flours in proportion of 27/69, 30, and 42/31%, respectively, for preparation of the dough (Shahsavan Tabrizi, 2021). Cress seeds (*Lepidium sativum*) were procured from a local market in Mashhad, Iran. The seeds were firstly soaked in distilled water (water to seed ratio of 30:1, pH 7) at room temperature (21ºC) and mixed for 18 minutes, followed by 15 minutes extraction. The extracted solution was then filtered and dried in an air forced oven at 60ºC and, finally, the powder was milled, sieved using a mesh 18 sifter, packed and kept at room temperature (Karazhiyan *et al.*, 2011a).

Basil seeds (*Ocimum Basilicum* L.) were procured from a local market in Mashhad, Iran. The seeds were firstly soaked in distilled water (water to seed ratio of 20:1) at 40ºC, then passed through an extractor to separate the slimy layer from the basil seed surface. The obtained solution was centrifuged for 30 minutes at 4,000 rpm and ambient temperature to precipitate the seed residues (Hosseini-Parvar *et al.*, 2015). Hydroxypropyl Methylcellulose (HPMC) was obtained from Petro Pars Novin Company, Tehran, Iran.

The bread formula consisted of quinoa, grass pea and chestnut flour in proportion of 27/69, 30, 42/31%, respectively. Then, water (the required amount according to Farinograph water absorption), active dried yeast (1 % w/w flour basis); salt (2 % w/w flour basis); shortening (1 % w/w flour basis) and Cress seed gum (C), Basil gum (B) and HPMC (H) hydrocolloids were added to the flour at four levels (0, 0.5 , 1, and 1.5% w/w flour basis). Combinations of these levels were performed in order to obtain the following samples (the sub index indicates the gum level): $C_{0.5}B_0H_0$, $C_1B_0H_0$, $C_{1.5}B_0H_0$, $C_0B_{0.5}H_0$, $C_0B_1H_0$, $C_0B_{1.5}H_0$, $C_0B_0H_{0.5}$, $C_0B_0H_1$, $C_0B_0H_{1.5}$. The baking procedure was followed based on typical methods (Caballero *et al.*, 2007; Payedar, 2013). Three stage of fermentation (Primary fermentation: 10 minutes 25ºC, Secondary fermentation: 10 minutes 30ºC, and Final fermentation (in the oven): 60 minutes 45ºC) were considered. Baking was carried out using a rotary oven Baking Industries of Mashhad, Iran) at 230ºC for 10 minutes. After cooling, bread samples were packed in polyethylene bags, stored at room temperature until future analysis (Caballero *et al.*, 2007; Payedar, 2013).

Physicochemical Analysis

Moisture (44–16 A), ash (08–01), Specific volume (72-10) were determined according to AACC-approved methods (AACC, 2000).

Porosity Analysis

To determine the bread porosity, image processing method was used with a digital camera (EOS 800D, Canon, Japan) and Image J software. The color images were first grayscaled and then thresholded using isodata algorithm. The porosity was measured from the ratio of white to the total numbers of pixels. This test was performed

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after baking in three replications (Haralick *et al.*, 1973).

Texture Analysis

The stiffness and extensibility of bread samples was measured with a Texture Analyzer (TVT 6700, Perten, Sweden) load cell during 2 and 72 hours after baking. A cylindrical probe with a diameter of 25 mm and height of 23 mm with the speed of 30 mm min^{-1} was used for cubic samples with dimensions of 5×5×5 (AACC, 2000; Pourfarzad *et al.*, 2011).

Image Analysis

For each treatment, (three samples of crust and crumb) the image processing method was measured with a digital camera (EOS 800D, Canon, Japan) and Image J software. To study the effect of processing parameters on color components of bread, the RGB color space images were converted to L*a*b space (Haralick *et al.*, 1973; Zheng *et al.*, 2006).

Sensory Analysis

The sensory analysis was conducted with a group of 10 trained panelists using a hedonic scale of five points (1: Dislike extremely, 5: Like extremely) to evaluate general appearance, crust appearance and color, crumb appearance and color, texture, aroma and taste, stalling 48 and 72 hours after baking, and overall acceptability (AACC, 2000; Gacula).

Statistical Analysis

In order to assess significant differences among the samples and Analysis Of Variance (ANOVA) was performed using a computerized statistical program called "SPSS" version 22. Results were reported as averages of each of the three replications (all treatments were evaluated in three batches). Duncan multiple range tests were used to study the statistical differences of means with 95% confidence.

RESULTS AND DISCUSSION

Physicochemical Characteristics

The results of the effects of different hydrocolloids (cress seed gum, basil gum and HPMC) on physicochemical properties of gluten-free bread are presented in Table 1. The percentage of moisture increased significantly with the addition of hydrocolloids up to 31.71%, and the water absorption increased by using gums. These results matched those of Sahraiyan *et al.* (2013), Naji *et al.* (2012), Karazhiyan *et al.* (2011b), and Razavi and Karazhiyan, 2009.

Basil gums are regarded as unique among natural hydrocolloid due to the combination of hydroxyl and other reducing sugars such as glucose and fructose, which retain and hold moisture (Karazhiyan *et al.*, 2011b). Behrouzian *et al.* (2014), Razavi and Karazhiyan (2009), and Barcenas *et al.* (2006) reported that cress seed gum and HPMC as a novel gum is able to absorb water more and quickly, the effect has been attributed to the hydroxyl groups in the hydrocolloid structure and chain conformation that allows more water interaction through hydrogen bonding (Bárcenas and Rosell, 2006; Behrouzian *et al.*, 2014; Razavi and Karazhiyan, 2009).

The percentage of ash and specific volume increased significantly with the addition of hydrocolloids, also percentage of porosity increased significantly with the addition of hydrocolloids up to 28.91%. Based on the results, the highest value was in the sample with 0% cress seed gum, 1% basil gum and 0% HPMC. These results matched those of Naji *et al.* (2012), Karazhiyan *et al.* (2011), Razavi and Karazhiyan (2009) (Karazhiyan *et al.*, 2011a; Naji Tabasi *et al.*, 2012; Razavi and Karazhiyan, 2009). A possible explanation for this result is that

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Table 1. Effect of hydrocolloids on physicochemical characteristics of gluten-free bread.[a]

Sample	Physicochemical characteristics			
	Moisture (%)	Ash (%)	Specific volume (mL g^{-1})	Porosity (%)
$C_{0.5}B_0H_0$	30.68±0.08^b	2.93±0.05^b	3.61±0.12^c	26.15±0.04^d
$C_1B_0H_0$	30.72±0.05^b	2.99±0.02^c	3.94±0.03^e	28.59±0.763^h
$C_{1.5}B_0H_0$	30.69±0.08^b	3.04±0.04^d	3.02±0.01^a	27.84±0.05^g
$C_0B_{0.5}H_0$	30.91±0.02^c	2.91±0.01^b	3.82±0.03^d	27.01±0.01^e
$C_0B_1H_0$	31.71±0.02^e	3.02±0.01^{cd}	3.99±0.11^e	28.91±0.02^i
$C_0B_{1.5}H_0$	31.28±0.02^d	3.12±0.02^e	3.00±0.05^a	27.12±0.01^f
$C_0B_0H_{0.5}$	27.34±0.04^a	2.71±0.02^a	3.11±0.02^a	24.91±0.02^a
$C_0B_0H_1$	30.66±0.04^b	2.89±0.02^b	3.40±0.06^b	25.12±0.03^b
$C_0B_0H_{1.5}$	30.92±0.03^c	2.92±0.03^b	3.54±0.09^c	25.33±0.03^c

[a] Means±SD in each column with different letters differ significantly ($P< 0.05$).

hydrocolloids can improve dough development and gas retention by increasing dough viscosity (Lazaridou *et al.*, 2007). Therefore, bread containing 1% basil gum had the maximum moisture, specific volume, and porosity. The effects of hydrocolloids on the structure of the produced bread rely on the hydrocolloid type and concentration. In addition, basil gum was more effective on increasing the viscosity and retaining the moisture in the dough. Therefore, the dough became sticky, without any expansion during the baking process, which caused a significant decrease in the bread specific volume during fermentation by reducing the number of gas cells. Further, an increase in both cress seed gum and basil gum concentration improved both the specific volume and porosity of the Gluten-free bread. Porosity represents the number and size of gas cells. Hydrocolloids are capable of strengthening the gluten matrix surrounding gas cells, leading to their maintenance during part baking. This result was confirmed with Hejrani *et al.* (2019). Basil gum including reducing sugars such as L-arabinose, L-fucose, D- Galacturonic acid, D-xylose and L-galactose are used by yeasts to improve their activity and give rise to the bread volume (Anderson, 1989).

Texture Characteristics

The stiffness of gluten-free bread significantly increased with length of storage time, and decreased with increasing hydrocolloid concentration. Figure 2 shows that, irrespective of storage time, stiffness decreased with increasing hydrocolloid concentration. Stiffness decreased significantly with the addition of hydrocolloids alone or in combination ranging from 8.25 to 5.21%. Based on the results, the lowest value was in the samples with 1 and 1.5% basil gum. As illustrated in Figure 2, the use of basil gum plays the most significant effect on increasing bread stiffness, compared to the bread with cress seed gum and HPMC. The least for stiffness (2 hours after baking) with better acceptability was obtained for the $C_0B_1H_0$ and $C_0B_{1.5}H_0$ sample (Figure 1), which can be explained by the higher water retention capacity of basil gum and higher moisture content, leading to softer bread. Mandala *et al.* (2008) reported that the type of hydrocolloid can influence the viscoelastic characteristics of the dough differently.

The extensibility of gluten-free bread increased with storage time (Table 2).

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Table 2. Effect of hydrocolloids on extensibility of gluten-free bread[a].

Sample	Extensibility (mm)	
	2 hours after baking	72 hours after baking
$C_{0.5}B_0H_0$	49.63±0.03[d]	44.39±0.08[c]
$C_1B_0H_0$	47.01±0.04[b]	40.06±0.02[b]
$C_{1.5}B_0H_0$	44.91±0.03[a]	39.65±0.04[a]
$C_0B_{0.5}H_0$	49.92±0.03[ef]	44.91±0.02[f]
$C_0B_1H_0$	50.48±0.03[g]	45.82±0.03[g]
$C_0B_{1.5}H_0$	51.66±0.01[h]	47.05±0.03[h]
$C_0B_0H_{0.5}$	47.21±0.04[c]	40.02±0.02[b]
$C_0B_0H_1$	49.87±0.02[e]	44.57±0.025[d]
$C_0B_0H_{1.5}$	49.96±0.03[f]	44.66±0.06[e]

[a] Means±SD in each column with different letters differ significantly ($P< 0.05$).

Figure 1. Effect of gums addition on stiffness of gluten-free bread. Means±SD with different letters differ significantly ($P< 0.05$).

Extensibility increased significantly with the addition of hydrocolloids to 51.66% (2 hours after baking) and 45.82% (72 hours after baking). Hejrani *et al.* (2019), Naji *et al.* (2012), and Lazaridou *et al.* (2007) reported the same result by adding hydrocolloids regarding the improved texture of gluten-free bread.

Image Characteristics

Color is a crucial factor affecting the acceptance and satisfaction of consumers in the selection of food products. Table 3 shows the averaged results of the image characteristics of gluten-free bread

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Table 3. Effect of hydrocolloids on image characteristics of gluten-free bread.[a]

Sample	Crust			Crumb		
	L^*	a^*	b^*	L^*	a^*	b^*
$C_{0.5}B_0H_0$	58.12±0.03[e]	20.51±0.17[a]	19.66±0.05[a]	71.15±0.06[e]	10.03±0.02[a]	17.30±0.04[b]
$C_1B_0H_0$	58.55±0.11[f]	20.42±0.05[a]	20.43±0.23[b]	71.69±0.11[f]	10.54±0.03[c]	17.64±0.04[d]
$C_{1.5}B_0H_0$	56.03±0.05[b]	20.49±0.05[a]	21.02±0.02[c]	69.10±0.18[d]	10.61±0.03[d]	17.88±0.07[e]
$C_0B_{0.5}H_0$	57.08±0.03[d]	21.34±0.03[b]	22.91±0.04[d]	68.14±0.04[c]	11.26±0.01[f]	20.86±0.10[g]
$C_0B_1H_0$	56.19±0.04[c]	21.98±0.01[c]	24.16±0.02[e]	66.97±0.02[b]	12.17±0.02[g]	21.52±0.03[h]
$C_0B_{1.5}H_0$	55.64±0.03[a]	23.04±0.03[d]	25.39±0.06[f]	60.11±0.04[a]	12.91±0.01[h]	24.10±0.09[j]
$C_0B_0H_{0.5}$	60.02±0.05[g]	20.47±0.085[a]	20.33±0.03[b]	72.13±0.03[g]	10.38±0.07[b]	17.11±0.1[a]
$C_0B_0H_1$	60.16±0.01[h]	20.53±0.01[a]	19.81±0.11[a]	73.00±0.10[h]	10.66±0.02[d]	17.49±0.04[c]
$C_0B_0H_{1.5}$	60.03±0.02[g]	20.47±0.03[a]	21.03±0.03[c]	73.21±0.02[j]	11.01±0.04[e]	18.10±0.04[f]

[a] Means±SD in each column with different letters differ significantly ($P< 0.05$).

elaborated with the different hydrocolloids alone or in combination. As shown in Table 3, the use of cress seed gum and basil gum resulted in reducing brightness for the bread crust, compared with the sample with HPMC. Adding cress seed gum and basil gum to the gluten-free bread formula could increase the a* and b* value, while these gums reduced brightness, compared to the HPMC samples. In general, the darker color of the bread is related to the darker color of cress seed gum and basil gums. The brown crust of bread is the result of non-enzymatic browning reaction (maillard type) between amino acids and reducing sugars. Cress seed and basil consist of reducing sugars, which participate in color reactions and increase color intensity. Caramelization is regarded as another reaction leading to the formation of bread color. The reaction is caused by the thermal decomposition of sugar during cooking (Raidl and MA, 1983).

Sensory Characteristics

Table 4 shows the averaged results of the hedonic sensory test evaluation of gluten-free bread elaborated with the different hydrocolloids alone. All gluten-free bread recipes were acceptable, as they received scores higher than 4 ranging from 4 to 5, except in stalling (72 hours after baking). The highest score for overall acceptability was obtained for the $C_0B_0.5H_0$ and $C_0B_1H_0$ preparation (Figure 2). The bread with 1% basil gum had the highest score of texture, crust and crumb color and general appearance ($P< 0.05$) (Table 4).

Bread contains 1% basil gum had the maximum stalling scores (48 hours after baking) and (72 hours after baking). Some parameters such as appearance, aroma, taste and texture can influence bread acceptability. The positive effect of basil gum on water absorption and moisture content was detected during partial baking of gluten-free bread, becaus the seed gums contain polysaccharides they absorb a lot of water, the results are consistent with those of some other studies by Hejrani *et al.* (2019), Mohammadi *et al.* (2014), and Naji *et al.* (2012).

Studies have found that flavor is the first and foremost criterion affecting food acceptance (Kia *et al.*, 2018). The bread with 0.5 and 1% basil gum had a higher score in terms of taste and aroma, compared with the other samples ($P< 0.05$) (Table 4).

Finally, Hejrani *et al.* (2019), Mohammadi *et al.* (2014) and Naji *et al.* (2012)

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Table 4. Effect of hydrocolloids on sensory characteristics of gluten-free bread.[a]

Sample	General appearance	Crust appearance and color	Crumb appearance and color	Texture	Aroma and taste	Stalling (48 hours after baking)	Stalling (72 hours after baking)
$C_{0.5}B_0H_0$	5.00±0.00[c]	5.00±0.00[b]	5.00±0.00[b]	4.80±0.447[bc]	4.80±0.447[b]	4.80±0.447[a]	3.80±0.836[bc]
$C_1B_0H_0$	5.00±0.00[c]	5.00±0.00[b]	5.00±0.00[b]	5.00±0.00[c]	4.80±0.447[b]	4.80±0.447[a]	3.80±0.447[bc]
$C_{1.5}B_0H_0$	4.00±0.707[a]	4.20±0.836[a]	4.20±0.836[a]	4.20±0.836[ab]	4.00±0.707[a]	4.00±0.707[a]	2.80±0.447[ab]
$C_0B_{0.5}H_0$	5.00±0.00[c]	5.00±0.00[b]	5.00±0.00[b]	5.00±0.00[c]	5.00±0.00[b]	4.80±0.447[a]	4.00±0.707[c]
$C_0B_1H_0$	5.00±0.00[c]	5.00±0.00[b]	5.00±0.00[b]	5.00±0.00[c]	5.00±0.00[b]	4.80±0.447[a]	4.20±0.836[c]
$C_0B_{1.5}H_0$	4.20±0.836[ab]	4.20±0.836[a]	4.20±0.836[a]	4.40±0.547[abc]	4.60±0.547[ab]	4.20±0.836[a]	2.60±0.547[a]
$C_0B_0H_{0.5}$	4.00±0.707[a]	4.20±0.836[a]	4.20±0.836[a]	4.00±0.707[a]	4.00±0.707[a]	4.00±0.707[a]	3.20±0.836[abc]
$C_0B_0H_1$	4.80±0.447[bc]	5.00±0.00[b]	5.00±0.00[b]	4.80±0.447[bc]	4.80±0.447[b]	4.60±0.547[a]	4.00±0.707[c]
$C_0B_0H_{1.5}$	4.20±0.836[ab]	4.60±0.547[ab]	4.60±0.547[ab]	4.80±0.447[bc]	4.80±0.447[b]	4.40±0.547[a]	3.80±0.836[bc]

[a] Means±SD in each column with different letters differ significantly ($P< 0.05$).

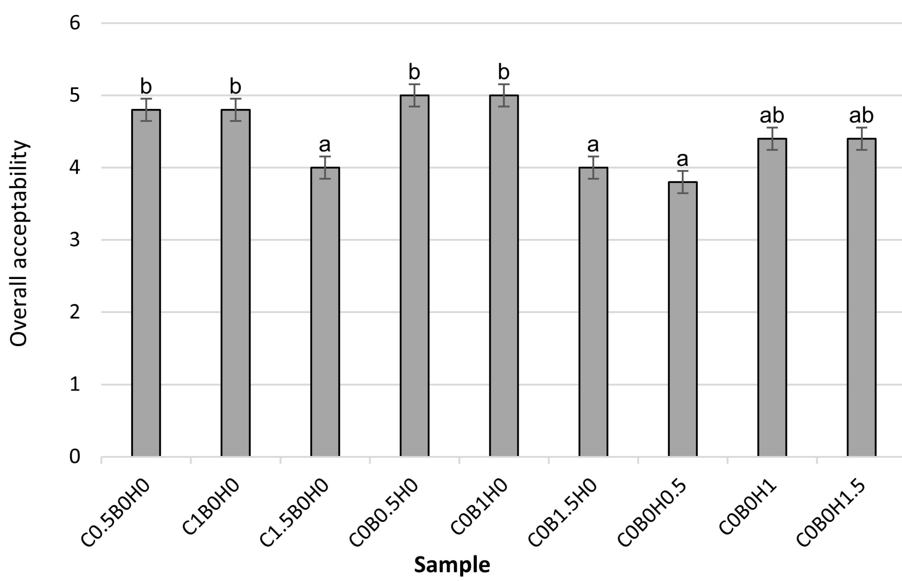

Figure. 2. Effect of gums addition on sensory panel overall acceptability score of gluten-free bread. Means±SD with different letters differ significantly ($P< 0.05$).

emphasized that the application of hydrocolloids in bread can improve its sensory properties.

CONCLUSIONS

In summary, this study has shown the effects of cress seed gum, basil gum, and HPMC in gluten-free bread recipes.Based on the results, the addition of basil gum to gluten-free bread recipe could improve the crumb texture, specific volume, sensory properties, as well as the overall quality of the product. Basil gum, as a novel gum, increased water absorption, texture, specific volume, and sensory properties alone.

Crumb stiffness decreased with increasing hydrocolloids concentration and increased with longer storage time, although the effect

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of basil seed gum on crumb stiffness reduction was more than cress seed gum and HPMC. Crumb extensibility increased with increasing hydrocolloids concentration and decreased with longer storage time, although the effect of basil seed gum and cress seed gum on crumb extensibility reduction was more than HPMC. Also, the results of bread quality parameters indicated $C_0B_1H_0$ had high specific volume and porosity. Therefore, basil seed gum can be a novel and useful gluten substitute for gluten-free bread baking purposes. The present study can provide better insights into the complexity of new sources of hydrocolloids and their influence on bread characteristics. Thus, it can serve as a guide for future research on other bread types.

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اثر صمغ‌های دانه شاهی و ریحان و هیدروکسی پروپیل متیل سلولز بر ویژگی‌های فیزیکی‌شیمیایی و بافتی نان بدون گلوتن

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چکیده

گلوتن یک پروتئین ساختاری برای محصولات نانوایی است و کمبود آن باعث تغییرات نامطلوب در بافت، رنگ و تخلخل این محصولات می شود. بنابراین استفاده از جایگزین‌های گلوتن مانند هیدروکلوئیدها، آنزیم ها و پروتئین‌ها در تهیه این محصولات ضروری است. هدف از این تحقیق بررسی خواص فیزیکوشیمیایی (حجم مخصوص، تخلخل، سفتی، کشش پذیری)، پارامتر رنگ و خواص حسی نان بدون گلوتن در حضور صمغ دانه شاهی (C) و صمغ ریحان (B) در مقایسه با هیدروکسی پروپیل متیل سلولز (HPMC)(H)در مقادیر صفر، ۰/۵، ۱ و ۱/۵ درصد بود. نتایج نشان داد افزودن صمغ‌ها به نان باعث کاهش سفتی و پارامترهای رنگ و افزایش حجم مخصوص، کشش پذیری و خواص حسی می‌شود. صمغ دانه ریحان در مقایسه با صمغ دانه شاهی و HPMC حجم مخصوص، تخلخل و نمره حسی را بیشتر بهبود بخشید. همچنین HPMC روی پارامتر رنگ نان بدون گلوتن موثرتر بود. از طرفی صمغ ریحان در فرمولاسیون نان بدون گلوتن بافت مغز نان، حجم مخصوص، خواص حسی و همچنین کیفیت کلی محصول را بهبود بخشید. نتایج پارامترهای کیفی نان نشان داد که نان های حاوی ۱ درصد صمغ دانه ریحان و فاقد صمغ دانه شاهی و HPMC دارای حجم ویژه و

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تخلخل بالایی بودند. بنابراین صمغ دانه ریحان می تواند یک جایگزین جدید و مفید گلوتن برای تهیه نان بدون گلوتن باشد.

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