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A Comparison between Effects of Quince Gum and Carboxymethyl Cellulose on Rheological, Textural, and Organoleptic Characteristics of Gluten-Free Cookies (Rice-Quinoa)

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ABSTRACT

Celiac disease is an autoimmune disorder which can cause serious damage to the mucous membrane of the small intestine due to the consumption of gluten, and as a result, there is a decrease in the absorption of nutrients, which can lead to weight loss, anemia and malnutrition. Removing gluten from the diet of the affected person is suggested as a solution to control and curb this abnormality. Therefore, the aim of this research is to investigate the possibility of producing cookies using rice flour, quinoa, carboxymethyl cellulose gum (1.5-3-5 percent) and gum extracted from the quince seed (1.5-3-5 percent) alone and evaluating its effect on the rheological characteristics of dough and textural properties of cookies. Based on the obtained results, it was determined that with the addition of gums, the viscosity increases compared to the control sample. Also by adding gums, Peak and Final viscosity increased and the setback viscosity decreased compared to the control sample. The highest maximum viscosity (1067 cp) and the highest final viscosity (1997 cp) were observed in the sample containing 5% quince gum. It was observed that the seed gum performed more effectively than showed carboxymethyl cellulose gum. So that the treatment with 5% quince gum has the highest viscosity among the samples. Furthermore the addition of both types of gum resulted in reduced hardness, increased springiness and improved sensory characteristics and The lowest hardness was observed in the sample containing 5% of quince gum to (19.33g). Based on the overall evaluation of the results of this study, treatment containing 450 g rice flour, 50 g quinoa flour and 5% quince gum is recommended as the best treatment.

1- Introduction

Cookie is a highly popular flour-based product that is widely consumed by people of different age groups. Its popularity stems from its ease of preparation, storage, and consumption, as well as its delicious taste, affordable price, and ability to provide energy. Hence, it is crucial to carefully consider the cookie formulation to enhance its nutritional quality. Cookies typically consist of wheat flour, sugar, and oil. The finished product usually contains a moisture content of 12-14% and can be stored for at least six months, or even longer, when properly packaged.

Gluten, a prominent protein found in wheat flour, is present in all varieties of cookies made with wheat flour. The gliadin component found in wheat gluten and the prolamin components found in the rye (scaline), barley (hordein), and oat (avidin) share similar amino acid compounds with gliadin. These components induce inflammatory reactions and mucus loss in the small intestine of individuals with celiac disease. Celiac disease is a genetic autoimmune disorder where the consumption of gluten leads to damage to the lining of the small intestine and prevents the absorption of vital nutrients. Adults with celiac disease experience symptoms such as weight loss, diarrhea, abdominal pain, anemia, and fatigue. The only way to prevent complications of this condition is to completely eliminate gluten from the diet [1-4]. The prevalence of this disease is on the rise, with one percent of the Iranian population currently affected. Consequently, there is a surge in the consumption and demand for gluten-free products [5]. Rice flour can serve as a replacement for wheat flour in order to eliminate gluten from products. Rice flour is considered a gluten-free option due to its mild flavor, easy digestibility, lack of allergenic properties, and low sodium levels [6, 7]. However, the removal of gluten from the food recipe will present difficulties such as a delicate texture, pale color, and reduced volume and porosity. This is because gluten, a vital structural protein found in wheat flour, possesses properties such as elasticity, endurance, and resistance to stretching. It also increases the capacity of dough to contain gas while mixing. These challenges can be overcome by adding hydrocolloids to the recipes [8-10].

Hydrocolloids or gums are a diverse group of polysaccharides that enhance the processing properties of dough, prolong its freshness, shape the dough, maintain its stability during fermentation, and extend the shelf life of the final product. CMC is a hydrocolloid that exists as a white, odorless powder extracted from cellulose and synthesized by reacting cellulose with sodium hydroxide and chloroacetic acid. CMC readily dissolves in cold water. Since heat causes viscosity to decrease, CMC can be used to control viscosity without gel formation at constant temperature. Hydrocolloids are also used as emulsifiers, stabilizers, and concentrates in the food industry [11-14].

Quince seed gum, derived from a fruit native to South Asia, is a natural hydrocolloid that can serve as a thickener and fat substitute. This is because it has a high extraction efficiency, high gelatinization capacity, and a large hydrodynamic volume. Because of its high viscosity, this gum is utilized in small amounts. Additionally, it exhibits strong hydrophilic properties and can absorb water up to 400 times its own volume [15-17].

Quinoa, a highly nutritious pseudo-cereal that is regarded as a novel plant in Iran, is considered a means of enhancing the nutritional value of food products [8]. The high nutritional value of quinoa can be attributed to the high content of amino acids, dietary fiber, vitamins, and minerals. Quinoa is a rich source of lysine, tryptophan, thiamin, ascorbic acid, mineral salts, and essential amino acids, such as lysine and methionine. The protein content of quinoa seeds ranges from 14% to 20% [9].

The substitution of rice and corn flour with quinoa flour at levels ranging from 40% to 100% for baking gluten-free bread yielded positive outcomes. Specifically, it enhanced the volume and porosity, softened the texture, increased the moisture content, and prolonged the freshness time of the bread [18]. Furthermore, Mousavi *et al*. (2019) conducted a study to enhance the quality of gluten-free biscuits made from rice flour. They found that optimizing the concentration of CMC resulted in the most favorable qualitative characteristics and overall acceptance of the biscuits. The recommended concentration for achieving these desirable qualities was determined to be 0.13% CMC [14].

This study aims to examine and compare the effects of CMC and quince gum on gluten-free cookie dough made from rice-quinoa flour. It also determines the appropriate ratio of wheat flour substitutes, the type of additive (gum), and the optimal level of the additive to preserve the rheological, textural, and organoleptic characteristics of the final product.

2-Materials and methods:

2-1- Materials

Quince seeds were purchased from Saharna Co., Tabriz, and stored in a refrigerator at -18℃; quinoa seeds, CMC, liquid oil, and sugar were purchased from O.A.B, Sun Rose Co. (Mashhad), Ladan Co., and Panizfam Sugar Co., respectively. Moreover, the chemicals used in this study were all from the German Merck.

2-2- Physicochemical assessment of rice flour and wheat flour

The physicochemical properties of rice flour and wheat flour, such as moisture content, protein content, ash content, and fat content, were determined using the standardized methods established by the American Association of Cereal Chemists (AACC). The moisture, ash, protein, and fat content was assessed based on standards 44-16, 08-01, 46-10, and standards 0-10, respectively.

2-3- Quince gum preparation

The quince seeds (Saharna, Tabriz) were ground and subsequently mixed with deionized water. The mixture was then heated indirectly over a flame for approximately 10 minutes, maintaining a temperature of 50-60℃. A magnet was employed to ensure complete separation of the gum. Then the mixture underwent filtration using an 80-mesh sieve and was subsequently transferred to a plate. The plate was introduced into a Memmert-D10383 oven (made in Germany) and left to dry for 5 to 6 hours until complete dehydration was achieved. The desiccated specimens were stored at 18℃ [19].

2-4- Preparation of cookies

Seven different kinds of cookie dough were prepared by mixing 4 g of baking powder, 0.20 g of vanilla, 70 g of sugar, 26 g of liquid oil, 26 g of solid oil, 13 g of eggs, and 36 g of water in a bowl mixer (PowerMix-rotel U44.3, Switzerland). Then rice and quinoa (at a ratio of 450 to 50 g) and quince gum and CMC (at four levels of 0, 1.5, 3, and 5) were added to the mixture (Table 1) [20].

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Table1-treatments

treatments	Rice flour(gr)	Quinoa flour(gr)	CMC(%)	Quince gum(%)
1	450	50	-	-
2	450	50	1.5	-
3	450	50	3	-
4	450	50	5	-
5	450	50	-	1.5
6	450	50	-	3
7	450	50	-	5

3-Tests:

3-1- Rheological evaluation

The rheological characteristics of rice flour-based dough were evaluated using a rapid visco analyzer (Newport, made in Australia). The samples, as specified in Table 1, were weighed precisely at a quantity of 3 g, and then 25 ml of distilled water was added to each sample. The adhesiveness of the samples was assessed by the rapid visco analyzer using the TCW program for 12.5 minutes. Accordingly, the temperature was kept stable at 50℃ for one minute before increasing it linearly to 95℃ for 3.8 minutes, and it was then kept stable for 2.5 minutes. Finally, peak viscosity, final viscosity, setback viscosity, and breakdown viscosity were determined based on Figure 1 [21].

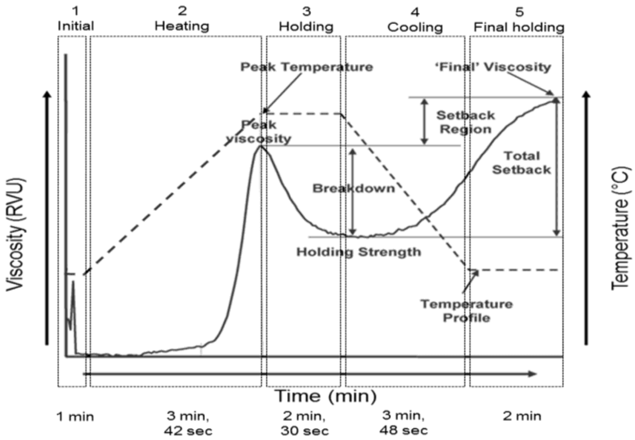

Fig 1 Overview of the viscosity curve in rice

3-2- Texture evolution

The cookie texture was evaluated using the TPA method (Brookfield-CT3, US). To this end, the cookie samples were cut into 25-mm pieces to be tested using a 25-mm diameter probe, which penetrated the sample by 50% between the first and second compression [22].

3-3- Organoleptic evaluation

The samples were encoded anonymously, accompanied by a form adhering to the AACC standard, specifically the 30-74 guideline. These samples were then distributed to 10 trained evaluators. The forms contained the attributes and their respective coefficients. The evaluators assigned points ranging from 1 to 5 to each attribute, which were then used to calculate

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the final score based on the special coefficient.

3-4- Statistical analysis:

The data obtained from testing 9 treatments based on a completely randomized design with three replicates were statistically analyzed in SPSS. Tukey's test was performed to compare the mean values at a 5% level of probability. The figures and tables were also drawn in Excel.

4-Results and discussion:

4-1- Physiochemical characteristics of rice and wheat flour

Table 2 presents the findings from the analysis of the physicochemical characteristics of rice flour used in the cookie recipe.

Table 2 Physicochemical properties of rice flour

Physicochemical properties (%)	Rice flour
Moisture	10.02
Protein	10.30
Ash	0.29
Fat	1.27

4-2- Rheological characteristics

Table 3 shows the effects of CMS and quince gum on the rheological characteristics of the resulting cookie dough. The results showed that the highest and the lowest peak viscosity were related to the samples containing 5% quince gum (cp 1067) and the control samples (cp 921). The results indicated that the peal viscosity increased with the increase in the quantity of gums, either industrial or herbal. Therefore, it can be concluded that there is a direct relationship between gum content and peak viscosity in the cookie dough. The absorption of water by starch granules leads to an increase in temperature, which in turn causes an increase in viscosity. This increase in viscosity continues until the granules reach their maximum swollen state and are about to burst, a state known as peak viscosity. The peak viscosity increases with the increase in the water absorption capacity of the sample. The addition of gums to rice and quinoa flour results in a higher water absorption capacity of the dough, which in turn leads to an increase in peak viscosity [23]. Final viscosity refers to the increase in viscosity after a period of cooling. The study results demonstrated that the highest and the lowest final viscosity were observed in samples containing 5% quince gum (cp 1997) and the control samples (cp 1913) (Table 3). It can be generally stated that final viscosity increases with the increase in the gum content, therefore, there is a direct relationship between gum content and final viscosity in the cookie dough. Gums possess hydrocolloid properties and a high molecular weight, enabling them to form a robust bond with water molecules. As a result, they enhance the overall viscosity and generate a compact gel network within the product. Consequently, hydrocolloids are anticipated to possess a significant water-binding capacity, resulting in increased viscosity and enhanced gas trapping. These characteristics contribute to the overall consistency of the dough. As shown in Table 3, the highest and the lowest setback viscosity were related to the control samples (cp 992) and the samples containing 5% quince gum (cp 930), respectively. The addition of CMC significantly reduced setback viscosity compared to the control samples. Setback viscosity has been shown to have an inverse relationship with the texture hardness and staleness. The setback viscosity is a measure of the dough's tendency to dry out during the cooling process; it is calculated by subtracting the peak viscosity from the final viscosity. Consequently, it is a crucial factor in determining the appropriateness of the dough and its inclination to become stale [24].

The results also showed that the highest and the lowest breakdown viscosity were related to the samples containing 5% quince gum (cp 190/66) and the control samples (cp 91), respectively. The addition of both CMC and quince gum generally increased the breakdown viscosity of the cookie dough, but the effects of quince gum seem to be greater (Table 3). Considering the fragility of the sponge-like structure in rice flour dough, it is desirable to increase the viscosity of the dough by adding hydrocolloids.

Table3 Mean of rheological properties

treatment	Peak viscosity	Final viscosity	Setback viscosity	Breakdown viscosity
1	921.33 ± 3.78^{d}	1913.66 ± 1.52^{c}	992.33 ± 8.73^{a}	91.00 ± 3.00^{c}
2	942.66 ± 5.50^{cd}	1915.00 ± 5.29^{c}	973.34 ± 4.35^{b}	107.66 ± 2.51^{c}
3	965.33 ± 6.02^{c}	1929.66 ± 2.08^{b}	964.33 ± 5.03^{b}	117.00 ± 9.53^{bc}
4	1007.66 ± 3.05^{b}	1982.00 ± 7.00^{a}	975.34 ± 3.05^{b}	129.00 ± 7.21^{b}
5	984.33 ± 3.51^{bc}	1923.66 ± 1.52^{bc}	939.33 ± 2.88^{c}	182.33 ± 5.50^{a}
6	996.33 ± 2.08^{b}	1931.33 ± 3.51^{b}	935.00 ± 5.29^{c}	148.66 ± 5.50^{b}
7	1067.00 ± 11.00^{a}	1997.66 ± 3.51^{a}	930.66 ± 10.01^{c}	190.66 ± 12.22^{a}

Each columns with the same code letters are not significantly different at $p \leq 0.05$

(1):control, (2):1.5% CMC, (3):3% CMC, (4):5% CMC, (5): 1.5% Quince gum, (6): 3% Quince gum, (7): 5% Quince gum

4-3- Textural characteristics

4-3-1- Hardness

The results showed that the highest hardness (47.16) was observed in the control samples (containing rice and quinoa flour) on the fifth day of the experiment (Table 4). The addition of gums reduced the hardness of cookies, and quince gum reduced it more significantly than CMC did (treatments 5, 6, and 7). The lowest hardness (19.33) was also related to the samples containing 5% quince gum. The resistance of cookies to deformation is a textural characteristic that expresses the stability and strength of the cookie. The level and progressive growth of this factor over time is a crucial determinant in assessing staleness, which is quantified through tissue analysis. The retrogradation of starch results in an increase in the connections between the gelatinized starch strands, which is what causes the staleness process. The initial moisture content in this process affects the set of reactions and the formation of its regular structure. The higher moisture content of the ingredients may be the cause of the slower rate of hardening as well as the lower final hardness following the storage period. The absence of gluten in gluten-free bakery products typically allows moisture to move from the inside to the outside of the product during baking. This causes the final product to lose its softness and become hard [4]. Therefore, the use of hydrophilic compounds that absorb and retain water within the system can partially inhibit the

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hardening process. As a result, the hardness reduces with the addition of gums because of the increased water absorption and retention [14]. Inadequate uniformity in the dough causes the gas bubbles to coalesce, resulting in their migration to the surface and subsequent release. The ultimate consistency is determined by the dough's capacity to retain gas while being cooked and the effect of the hydrocolloid on the temperature at which starch gelatinizes. If the hydrocolloid raises the gelatinization temperature, it will cause the emulsion of liquid and air paste to solidify, providing sufficient time to increase volume and porosity. Low viscosity prevents the trapping of CO2 and water vapor by air cells during cooking, leading to a low specific volume. In addition to viscosity, the ratio of amylose to amylopectin, the presence of surface active compounds, and the accumulation of heat-generated proteins can affect porosity. The gel structure formed by seed mucilage can serve the same purpose as fat. The gelatinization capacity of certain hydrocolloids suggests their potential as fat substitutes.

4-3-2- Adhesiveness:

The study results demonstrated that the highest and the lowest adhesiveness were related to Sample 6 (containing 5% quince gum) (1.46) and the control sample (0.11), respectively. The addition of gum generally increased the adhesiveness of cookies, and quince gum was more effective than CMC in this regard. The adhesiveness of cookies also showed an upward trend with the increased duration of storage.

4-3-3- Cohesion:

The results indicated that the highest cohesion was observed in Sample 7 (containing 5 quince gum). In addition, the cohesion of samples increased with the increase in the content of gums added to the recipes. Cohesion describes the internal resistance of the cookie structure, which has an inverse relationship with its hardness; this means that cookies that get stale more quickly are less cohesive.

4-3-4- Springiness:

The results showed that the lowest and the highest springiness were related to the control sample (0.22, 5th day) and Treatment 7, respectively. The addition of both industrial and herbal gums improved the springiness of cookies, but quince gum was more effective than CMC in this regard. The springiness of cookies also reduced with the increasing duration of storage as well as the increase in staleness and moisture loss. That is why the cookie loses more moisture and its springiness reduces with the increased duration of storage. The addition of gums also improves water absorption and retention, which enhances moisture retention and increases springiness.

Table4 texture profile analyses of samples during storage

treatment	day	Hardness(g)	Adhesiveness(mj)	cohesiveness	Springiness(mm)
	1	$34.87 \pm 0.15^{a\,B}$	$0.11 \pm 0.02^{e\,B}$	$0.01 \pm 0^{d\,A}$	$0.56 \pm 0.02^{e\,A}$
1	3	$37.91 \pm 0.01^{a\,B}$	$0.22 \pm 0.01^{c\,A}$	$0.01 \pm 0^{e\,A}$	$0.40 \pm 0.01^{f\,B}$
	5	$47.16 \pm 0.01^{a\,A}$	$0.22 \pm 0.01^{e\,A}$	$0.01 \pm 0^{c\,A}$	$0.22 \pm 0^{e\,C}$
	1	$33.82 \pm 0.02^{a\,C}$	$0.32 \pm 0.01^{d\,C}$	$0.1 \pm 0^{c\,A}$	$2.20 \pm 0^{d\,A}$
2	3	$37.23 \pm 0.02^{a\,B}$	$0.85 \pm 0.01^{a\,A}$	$0.08 \pm 0^{d\,A}$	$2.02 \pm 0.02^{d\,B}$
	5	$46.22 \pm 0.02^{a\,A}$	$0.61 \pm 0^{d\,B}$	$0.02 \pm 0^{c\,B}$	$1.25 \pm 0.02^{d\,C}$
	1	$33.77 \pm 0.02^{a\,B}$	$0.54 \pm 0.02^{c\,B}$	$0.12 \pm 0.01^{c\,A}$	$2.48 \pm 0.02^{c\,A}$
3	3	$36.45 \pm 0.02^{a\,B}$	$0.53 \pm 0^{b\,B}$	$0.08 \pm 0.01^{d\,B}$	$1.75 \pm 0.02^{e\,B}$
	5	$42.52 \pm 0.04^{b\,A}$	$0.66 \pm 0.01^{d\,A}$	$0.07 \pm 0^{b\,B}$	$1.44 \pm 0.02^{d\,C}$
	1	$31.76 \pm 0.02^{b\,C}$	$0.31 \pm 0.01^{d\,C}$	$0.12 \pm 0.01^{c\,A}$	$2.54 \pm 0.02^{bc\,A}$
4	3	$36.86 \pm 0.01^{a\,B}$	$0.53 \pm 0.03^{b\,B}$	$0.09 \pm 0^{d\,B}$	$2.14 \pm 0.01^{c\,B}$

	5	40.03 ± 0.03$^{b\ A}$	0.86 ± 0.02$^{c\ A}$	0.08 ± 0$^{b\ B}$	1.54 ± 0.04$^{d\ C}$
	1	26.03 ± 0.03$^{c\ B}$	0.76 ± 0$^{b\ B}$	0.12 ± 0.01$^{c\ A}$	2.68 ± 0.02$^{b\ A}$
5	3	27.05 ± 0.01$^{b\ B}$	0.80 ± 0$^{a\ B}$	0.12 ± 0.02$^{c\ A}$	2.12 ± 0$^{c\ B}$
	5	30.32 ± 0.02$^{c\ A}$	1.11 ± 0.02$^{b\ A}$	0.06 ± 0.01$^{b\ B}$	2.12 ± 0.02$^{c\ B}$
	1	21.63 ± 0.01$^{d\ B}$	0.85 ± 0$^{a\ B}$	0.19 ± 0.01$^{b\ A}$	2.63 ± 0.03$^{b\ A}$
6	3	22.54 ± 0.02$^{c\ B}$	0.75 ± 0.01$^{a\ B}$	0.17 ± 0.01$^{b\ B}$	2.52 ± 0.01$^{b\ B}$
	5	26.34 ± 0.03$^{d\ A}$	1.42 ± 0.01$^{a\ A}$	0.16 ± 0$^{a\ B}$	2.66 ± 0.01$^{a\ A}$
	1	19.33 ± 0.02$^{e\ B}$	0.84 ± 0.03$^{a\ B}$	0.22 ± 0.01$^{a\ A}$	2.95 ± 0.02$^{a\ A}$
7	3	20.06 ± 0.03$^{c\ AB}$	0.74 ± 0.02$^{a\ B}$	0.22 ± 0.02$^{a\ A}$	2.82 ± 0.01$^{a\ A}$
	5	22.31 ± 0.02$^{e\ A}$	1.46 ± 0$^{a\ A}$	0.18 ± 0$^{a\ B}$	2.20 ± 0$^{b\ B}$

4-4- Organoleptic characteristics

Figure 2 presents the results of evaluating the organoleptic characteristics of cookie samples, including the effects of CMC and quince gum. The results indicated that the best organoleptic characteristics were observed in Treatment 7 (containing 3% quince gum).

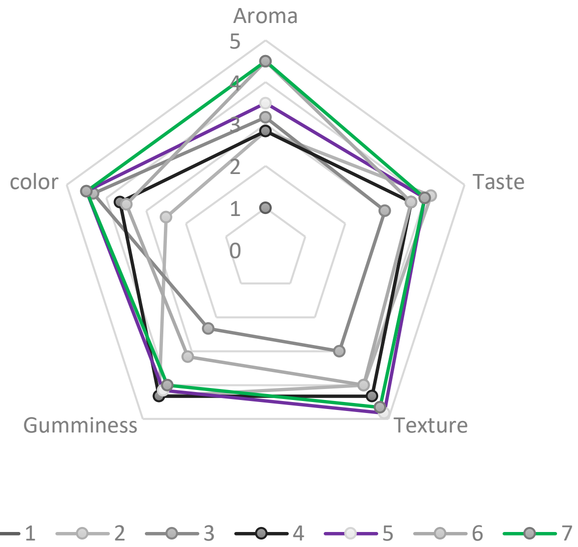

Fig2 The effect of adding CMC and Quince gum on sensory properties of cookies

(1):control, (2):1.5% CMC, (3):3% CMC, (4):5% CMC, (5): 1.5% Quince gum, (6): 3% Quince gum, (7): 5% Quince gum

5-Conclusion:

Celiac disease is an autoimmune disorder characterized by serious damage to the digestive system caused by the ingestion of gluten. Patients with celiac disease are usually recommended to go on a gluten-free regime as a treatment option. The high gluten content of wheat flour gives a desirable texture to flour-based products. This study aimed to enhance the texture of cookies by substituting wheat flour and gluten with rice flour, CMC, and quince gum. Quinoa flour was also added to the formulation of cookies to enhance the beneficial properties of the final product. The results of using a mixture of rice flour and quinoa flour, CMC (1.5, 3, and 5%), and quince gum (1.5, 3, and 5%) demonstrated that the addition of gums improved the rheological, textural, and organoleptic characteristics of cookies. Accordingly, the increasing amount of gums in the recipe of cookies increased peak and final viscosity but reduced setback

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viscosity. The study results showed that the high peak viscosity (cp1067) and final viscosity (cp1997) were observed in the sample containing 5% quince gum. In addition, the best rheological, textural, and organoleptic characteristics were observed in Treatment 7, which contained rice flour, quinoa flour, and 5% quince gum.

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چکیده

بیماری سلیاک یک ناهنجاری خودایمنی بوده که افراد مبتلا، به سبب مصرف گلوتن دچار آسیب جدی در مخاط روده کوچک شده و در نتیجه آن کاهش جذب مواد مغذی رخ می‌دهد که می‌تواند منجر به کاهش وزن، کم‌خونی و سوتغذیه شود. حذف گلوتن از رژیم‌غذایی فرد مبتلا به عنوان راه حلی برای کنترل ومهار این ناهنجاری پیشنهاد می‌گردد. لذا هدف از این پژوهش، بررسی امکان تولید کلوچه با جایگزینی آرد برنج و آرد کینوا به جای آرد گندم همراه با به کارگیری صمغ کربوکسی‌متیل‌سلولز (١/٥ – ٣ – ٥ درصد) و صمغ استخراج شده از دانه‌ی به (١/٥ – ٣ – ٥ درصد) به عنوان عوامل بهبوددهنده و ارزیابی تاثیر آنها در ویژگی‌های رئولوژیکی خمیر و صفات بافتی و حسی کلوچه می‌باشد. بر اساس نتایج بدست آمده مشخص گردید که میزان ویسکوزیته با بالا رفتن میزان صمغ‌ها روندی افزایشی داشته است و با افزودن غلظت آنها، افزایش ویسکوزیته حداکثر و نهایی و کاهش ویسکوزیته برگشت‌پذیری نسبت به نمونه شاهد مشاهده گردید، به طوریکه بیشترین میزان ویسکوزیته حداکثر(١٠٦٧cp) و بالاترین مقدار ویسکوزیته نهایی (١٩٩٧cp) در نمونه حاوی ٥ درصد صمغ دانه به دیده شد. بعلاوه صمغ دانه‌به عملکرد موثرتری نسبت به صمغ کربوکسی‌متیل‌سلولز از خود نشان داد، به‌طوریکه تیمار حاوی صمغ دانه‌به به میزان ٥درصد بیشترین میزان ویسکوزیته حداکثر و نهایی را در میان نمونه‌ها دارا است. همچنین افزودن هر دو نوع صمغ منجر به کاهش سفتی، افزایش فنریت و بهبود ویژگی‌های حسی شده و کمترین میزان سفتی در نمونه حاوی ٥ درصد صمغ دانه به (١٩/٣٣g) مشاهده شده است. بر اساس ارزیابی کلی نتایج تحقیق حاضر، تیمار حاوی ٤٥٠ گرم آرد برنج، ٥٠ گرم آرد کینوا و ٥ درصد صمغ دانه‌به به عنوان بهترین تیمار پیشنهاد می‌گردد.