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Investigating the application of sugar beet pulp and sourdough on the quantity and quality of baguette bread

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ABSTRACT

Bread is one of the most important foods based on the wheat that plays a vital role in feeding the people in the world as an excellent source of energy and protein. Therefore, the development of enriched bread is one of the effective ways in providing some of the necessary nutrients of the people. this study aimed to examine the effect of sugar beet pulp and sourdough on physicochemical, textural and organoleptic properties of baguette bread. To do this, the pressed sugar beet pulp in three levels of 2, 6, and 10% and sourdough in three levels 5, 10 and 15% were added based on the weight of flour in the dough preparation stage,respectively. Color, texture, moisture, water activity, specific volume and sensory evaluation tests were performed after preparing the samples. The results showed that increasing the amount of sugar beet pulp and sourdough in baguette formulation made moisture content, specific volume and overall acceptance increase and a* decreased. Also the effect of sugar beet pulp on b* was less than sourdough and time, and sourdough had more effect on flavor than sugar beet pulp and time factors. Therefore, the sample containing 6% sugar beet pulp and 10% sourdough as the optimal sample improved the quality characteristics of baguette bread.

1. Introduction

Bread is the most important food based on wheat that is produced all over the world and it is also the most popular product that is consumed in Iran [1]. More than half of the energy and protein intake of humans is provided through the consumption of bread. According to available statistics, 30% of this product is left as waste from the food basket every year, which is equivalent to 2 million tons of wheat. This is while 3 to 5 million tons of wheat enters the country, which is actually equal to the amount of waste in this sector [2,3]. Staleness is one of the factors that play a very important role in causing bread spoilage. Staleness is a change in the appearance, taste, taste and texture of bread and ultimately reducing its acceptance by the consumer. In other words, physicochemical changes that reduce the quality of bread are called staleness [2 and 4]. Today, there are many ways to reduce the staleness of bread. Among these methods, we can mention the use of gums and fibrous materials in bread formulation in order to reduce staleness and improve the quality of bread [6, 5]. Fiber is a general term that includes different types of non-starch carbohydrates and lignin [7]. In addition to the beneficial effects they have on health, dietary fibers are also widely used in the food industry due to their proper functional characteristics such as water absorption, oil absorption and viscosity increase [8, 9, 10 and 11]. One of the abundant and cheap sources of fiber is the waste of factories processing raw agricultural products. Sugar beet pulp can be mentioned among the wastes containing high fiber. The water holding capacity of this fiber is higher than cereal fibers and it can be used as a filler in food industries. Also, the amount of phytic acid in sugar beet pomace fiber is small and its consumption does not interfere with iron absorption [7, 12 and 13]. Majzoubi et al. (2012) reported that sugar beet pulp mainly increases the consistency and stability of dough. Therefore, it is suitable for preparing doughs made from weak flour or for preparing dough with high consistency. Sugar beet pomace can be used in the preparation of bread dough whose production process (including mixing and fermentation) is long. Because these steps cause the dough to loosen and the presence of sugar beet pomace can maintain the consistency of the dough [14]. Mahdian et al. (2012) investigated the effect of adding sugar beet pomace fiber on the physicochemical characteristics of toasted bread. The results showed that the addition of sugar beet pomace fiber to wheat flour has many positive features such as increasing the amount of water holding capacity and as a result maintaining the freshness of bread (delaying staleness), increasing fiber, reducing dough processing time, reducing baking time, improving the fermentation process, increasing value. bread had nutritional value and therefore the mentioned substance is considered a suitable additive to improve the quality of toasted bread [15]. Shovornia-Simovich et al. (2021) investigated by-products rich in dietary fiber, such as sugar beet fiber and carob pod powder, on the rheological properties of dough, the results indicate that the dough resistance with the addition of SBF and CF in the dough is 55 and 75%, respectively. increased, also the combined effect of CF and SBF increased the dough strength by 100% [16].

Another effective way to improve the sensory and functional quality of bread is to use biological processing techniques such as sourdough. Yeasts and lactic acid bacteria form sourdough microbes that produce various organic acids and special flavoring substances such as alcohols, aldehydes, and esters during the fermentation process and create a pleasant taste and aroma in bread [17]. Sourdough fermentation can improve the health of grain production in several ways: it can improve the texture and taste of whole grains, produce fiber-rich or gluten-free products, stabilize or increase the level of various bioactive compounds, delay the availability of starch (products with lower glycemic) and also improve the biological supply of minerals [18]. In this regard, Arnett et al. (2007) investigated the effect of sourdough on the texture of gluten-free bread. The studies presented in this review showed that adding sourdough reduced staleness and improved bread quality, increased bioavailability of minerals and reduced phytate content [19]. Pazoki et al. (2018) in the study of the effect of using sourdough prepared from hard and soft flour on the physicochemical and sensory

characteristics of baguette bread, stated that the samples produced from stronger flour had higher moisture and specific volume, more porosity, and less hardness and staleness [20].

Considering the society's need in the field of reducing waste and increasing the quality and shelf life of bakery products, the purpose of this research is to investigate the effect of sugar beet pulp and sourdough on the physicochemical, textural and sensory properties of baguette bread.

2- Materials and methods

2-1- Materials

Consumables needed for making baguette include premium Star flour with extraction degree of 83% and chemical characteristics including moisture (12.8%), ash (0.676%) and wet gluten (25.7%) from Quds Flour Special Joint Stock Company Razavi, Laden liquid oil, sugar from Neyshabur Sugar Factory, sourdough from Razavi Yeast Company, improver from Sahar Company, sugar beet pomace from Torbat-Haidaryeh Sugar Factory, salt and sourdough were purchased from the local market.

2-2- Methods

2-2-1- Slag preparation

Pressed sugar beet pulp was prepared from sugar factory and dried at 60 degrees Celsius. The dried pulp was milled and sieved with a 60-mesh sieve and the resulting powder was packed in polyethylene bags and then kept at a temperature of 25 degrees Celsius in an environment without light and humidity until use [21].

2-2-2- Preparation of sour dough

For this ratio, 100 parts of flour, 50 parts of water, 3% of salt, 2% of yeast and fermentation time (240 minutes) were used. 5, 10 and 15% of this amount of sourdough was added to the dough in the mixer [22].

2-2-3- Preparation of bread samples

In order to produce a baguette, the ratio of the main components: including 100% premium star flour, water (according to Farinograph water absorption), active dry yeast (1.5%), improver (0.25%), salt (1.4 percent), sugar (1 percent), oil (0.5 percent), sugar beet pulp and sour dough were mixed in the mixer tank for 2 minutes without water. Then about 1.5 liters of water was added to it and mixed at low speed for 3-4 minutes and again at medium speed for another 3 minutes, finally it was mixed at high speed for 4 minutes. After completely mixing the material with water and forming a malleable dough, the sample was rested for 7 minutes. Then the pieces of dough were crushed and rounded, and based on this, the samples were given an intermediate rest period of 5 minutes. After cutting the dough, it enters the rolling machine[1] To perform the final stage, they were fermented and kept at 37°C with 80% relative humidity for 45 minutes. Finally, they were placed in the oven at a temperature of 220 degrees Celsius for 15 minutes. After cooling, each bread sample was packed in polyethylene bags and kept at room temperature (25°C). In this study, the amount of sugar beet pomace (6.2 and 10% based on the weight of flour), the percentage of sourdough (10.5 and 15% based on the weight of flour) and storage times (0, 48 and 96 hours) were [23].

2-2-4-Examinations under review

2-2-4-1- Physicochemical

2-2-4-1-1 Humidity test

Humidity was measured according to Iranian national standard No. 2705 [24].

2-2-4-1-2-measuring the specific volume of bread

To measure the specific volume of bread samples, the method of replacing the volume with millet grain was used according to AACC 2000 standard No. 10-72. For this purpose, at time intervals of zero, 48 and 96 hours after baking, a separate piece of each bread sample measuring 2 x 2 x 2 cm was weighed with a digital scale, then the volume of the graduated cylinder was replaced with 250 ml of millet seeds. Then the intended piece of bread was placed inside the graduated cylinder and the final volume was reported. Finally, the specific volume was calculated by dividing the volume by the weight [25].

2-2-4-1-3-measurement of water activity

The water activity of each sample was measured using a water activity measuring device (Lab Touch model, made in England) at a temperature of 25 °C [26].

2-2-4-2- Histological test

1. Rolling machine

To measure the samples from the histometer device[2] Made in America, LLOYD model was used**.** For this purpose, a cube piece of bread with cm dimensions[3] 3x3x3 was compressed twice by the machine probe, the probe speed is 100 mm/min and the probe diameter is 50 mm. In this method, parameters such as hardness (the maximum force required to squeeze the food between the molars until a certain shape change is achieved), breaking force (depends on the consistency and hardness of the food texture) were investigated [1].

2-2-4-3- Evaluation of bread crust color:

The analysis of bread crust color was determined by image processing and using Image J software, and L*, a*, and b* indexes were measured [27].

2-2-4-4 Evaluation of sensory characteristics of different bread treatments:

In this research, a panel group of 5 people was used for sensory evaluation. The attributes of appearance, aroma, taste and texture were investigated. Sensory indices of bread samples were examined at three times zero, 48 and 96 hours after the baking process using the five-point method [28].

2-3-Analysis and statistical analysis

This experiment was carried out in the form of Benken's box statistical design with independent variables of sugar beet pomace addition, sourdough percentage and storage times and dependent variables including physicochemical test, sensory evaluation, histometry, color. In order to analyze data and draw graphs, Minitab software version 16 was used.

Table 1 Independent variables (sugar beet pulp, sourdough and time) and levels used in the box-bancon design

Row	sugar beet pulp	sourdough	time
1	2	10	0
2	2	10	96
3	2	5	48
4	10	5	48
5	10	10	0
6	6	5	0
7	10	10	96
8	2	15	48
9	6	15	96
10	10	15	48
11	6	5	96
12	6	10	48
13	6	10	48
14	6	10	48
15	6	15	0

2. TPA (Texture Profile Analyzer)

3. Results and Discussion

3-1- Examining the effect of variables on humidity

One of the most important technological factors of bread is its moisture content. Characteristics such as feeling of freshness, having a good mouth feel, delay in staleness and duration of bread storage are directly influenced by its moisture content [29]. Also, water plays a very important and vital role in bread staleness. To investigate the relationship between the process variables and the amount of moisture as a measured response, the quadratic model regression equation was used (Equation 1):

= humidity -17.47 + 6.28 Beet pulp
+ 4.57 sourdough + 0.2403 Time –
0.3958 Beet pulp*Beet pulp –
0.1678 sourdough*sourdough –
0.002667 Time*Time – 0.01257 Beet pulp*Time

As shown in Figure (a-1), with the increase in the amount of sugar beet pomace and sour dough, the percentage of moisture also increased ($P<0.05$). According to the shape, the greatest effect for this parameter is related to sourdough. Also, with the increase of beet pomace up to 6%, the amount of moisture increased greatly, but after that, the amount of moisture decreased. Majzoubi et al. (2009) reported in their research that with the increase in the amount of sugar beet pomace in the dough due to the pomace's ability to absorb water, the amount of water absorption increased greatly, which was consistent with the results of this study. The reason for this problem is the presence of hydrocolloid compounds, including water-insoluble fiber sources such as cellulose and hemicellulose [30]. For this reason, the presence of these substances in bread dough increases the amount of water absorption. Toriri et al. (2014) investigated the effect of sourdough on the shelf

life and quality of bread. The results showed that the addition of sourdough caused shelf life, higher moisture and better mechanical properties of bread during shelf life [31].

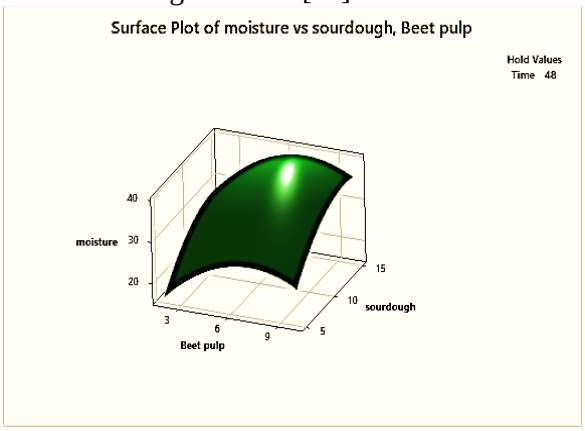


Fig 1 Interactive effect of sugar beet pulp and sourdough parameters on moisture (a)

2-3- Examining the effect of variables on specific volume

To investigate the relationship between process variables and specific volume as a measured response, the following regression equation was used (Equation 2):

= specific volume

-2.117 + 0.764 Beet pulp + 0.457 sourdough
+ 0.02636 Time
- 0.0489 Beet pulp*Beet pulp –
0.01675 sourdough*sourdough
- 0.000271 Time*Time – 0.001682 Beet pulp*Time

According to the results of variance analysis of specific volume, it was observed that three independent factors of sugar beet pomace, sour dough and time had a significant effect ($p<0.05$) on specific volume. As shown in Figure (a-2), with increasing the percentage of beet pomace up to 9% and increasing the amount of sour dough, the specific volume also increased. Figure (-b2) shows the separate effect of each of the independent parameters on the specific volume. The biggest effect in this parameter is related to increasing the percentage of sourdough (up to 14%). Also, this graph showed that with the increase of time, the specific volume initially increased, but then the specific volume decreased drastically, the reason for this phenomenon can be explained as the fibers in the beet pulp cause the gluten to be diluted, but due to the effect on the stability of the air bubbles. During the formation and after that during storage, they increase the volume and softness of the bread texture [32]; These results were consistent with the reports of Katina et al. (2006) [33]. The results of these researchers showed that adding sourdough to the bread formulation increased the volume of bread, which was consistent with the results of this research.

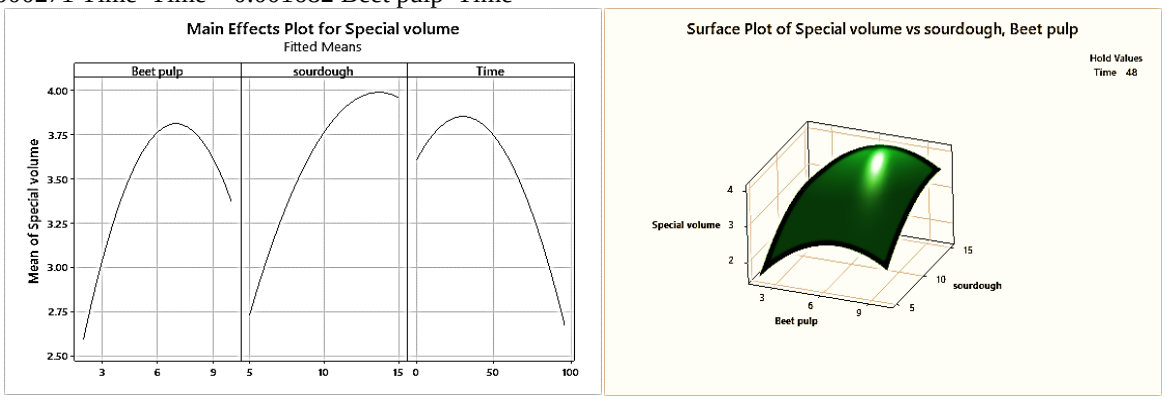


Fig 2 Interactive effect of sugar beet pulp and sourdough parameters on specific volume (a) effect of process parameters on specific volume (b)

3-3- Examining the effect of variables on water activity

In Figure (a-3), the significant interactive effect of sugar beet pomace and sourdough parameters on water activity is shown. As shown in the picture, increasing the amount of sugar beet pomace up to 9% and sour dough up to 10%, the water activity percentage of the samples also increased. As can be seen, the biggest effect on the amount of water activity is related to the parameter of sourdough percentage, which increased the amount of sourdough to more than 10%. Another effective parameter on water

activity was related to the percentage of sugar beet pulp. By increasing the percentage of sugar beet pomace to about 9%, the amount of water activity also increased, but when the percentage of sugar beet pomace increased to more than 9%, the amount of water activity also decreased. Research shows that the presence of sourdough leads to an increase in yeast growth and carbon dioxide production, and on the other hand, by increasing the proteolytic activities of free water, it connects with the gluten network and reduces the rate of staleness, which was consistent with the results of Karimi et al. (1400). [34].

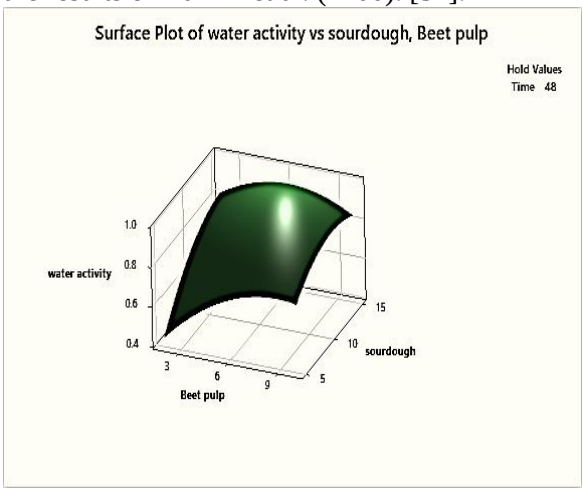


Fig 3 Interactive effect of sugar beet pulp and sourdough parameters on water activity (a)

Prophet Doost et al (2013) studied the effect of dried sourdough containing a mixture of Lactobacillus species on the quality of wheat flour and the rheological properties of the dough. They stated that the presence of exopolysaccharides produced by lactic acid bacteria during the fermentation of sourdough in flour increased the water activity of the flour. And for this reason, the dough made from flour containing sourdough needs more water for preparation and its water absorption increases [35].

3-4- Examining the effect of variables on tissue characteristics

3-4-1 The degree of tissue stiffness

To investigate the relationship between the process variables and the degree of stiffness as a measured response, the following regression equation was used (Equation 3):

سفتی = -0.35 + 0.918 Beet pulp + 0.702 sourdough + 0.0165 Time – 0.0648 Beet pulp*Beet pulp – 0.0260 sourdough*sourdough – 0.000347 Time*Time

In Figure (a-4), the interactive effect of sugar beet pomace and sour dough parameters on the hardness of the samples is shown. It has also been shown that by increasing the amount of sugar beet pomace up to 9% and increasing the amount of sour dough, the hardness of the samples also increased. Also, the separate effect of each of the independent parameters on the stiffness of the samples is shown in Figure (b-4). As it can be seen, the biggest effect on the degree of hardness is related to the parameter of sour dough percentage. Therefore, with the increase in the percentage of sour dough and beet pomace more than 13 and 7%, respectively, the degree of hardness increased greatly. But as the percentage of sugar beet pomace increased to more than 8%, the stiffness of the tissue decreased. Also, with the increase of the time, the hardness of the tissue of the samples decreased significantly. In other words, during storage and with the passage of time, the moisture content moves from the core of the bread and comes to the crust. In such a way that during the storage period, the moisture content of the bread core decreases and is transferred to the bread crust and the moisture level of the bread crust increases. As a result, evaluating the moisture content of bread core can be of special importance [29]. Majzoubi et al. (2009) stated that the hardness of the bread core tissue decreases with the increase in the percentage of sugar beet pomace [30]. Also, the stiffness of the bread core immediately after baking was lower in different treatments containing sugar beet pomace compared to the control sample. The presence of sugar beet pomace in bread reduces the hardness and improves the texture of the bread. The results of these researchers were consistent with the results of this research.

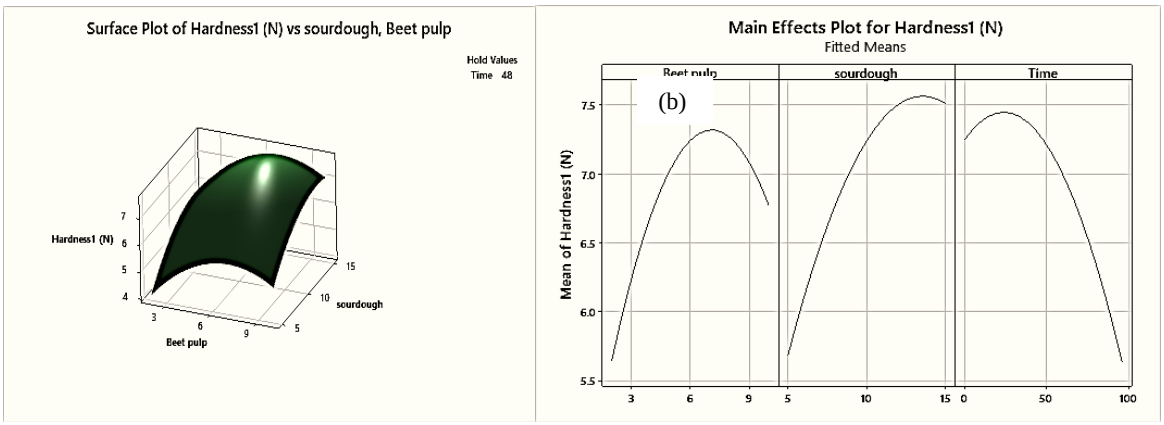


Fig 4 Interactive effect of sugar beet pulp and sourdough parameters on Hardness (a) effect of process parameters on Hardness (b)

3-4-2- breaking force

Figure (a-5) shows the separate effect of each of the independent parameters of sour dough and time on the breaking force of the samples. So that the biggest effect on the breaking force is related to the sour dough percentage parameter. According to the shape, with the increase in the percentage of sourdough and duration, the breaking force also increased and decreased respectively.

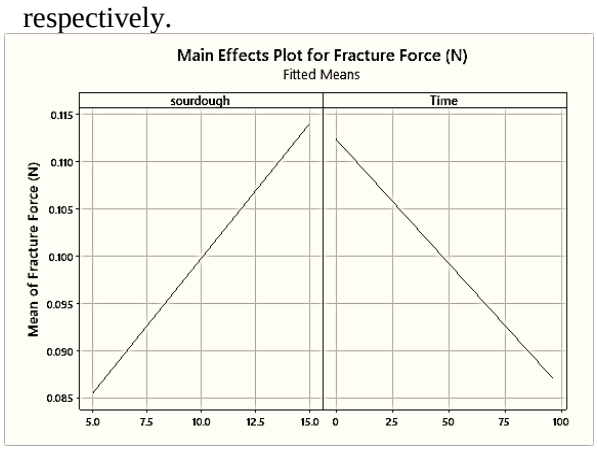


Fig 5 The effect of independent parameters of sourdough and time on fracture force(a)

5-3- Examining the effect of variables on color characteristics

3-5-1 brightness*L)

According to figure (a-6), it shows the interactive effect of sugar beet pulp parameters and time on the brightness of the samples. As can be seen, the brightness of the samples decreased with the increase of sugar beet pulp and time. But the amount of sour dough had a significant effect on the brightness of the samples. The presence of dark pigments in sugar beet pomace reduces the brightness factor in the crust and core of bread, which increases with the increase in pomace percentage and the density of pigments [30]. In (2009), Pourlis et al. stated during a research that the brightness of a food item is strongly influenced by the surface characteristics of a product and having a wrinkled and wrinkled surface has a significant effect on this parameter [36].

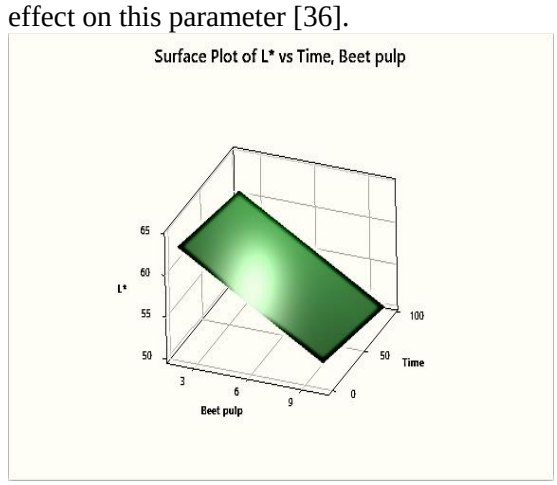
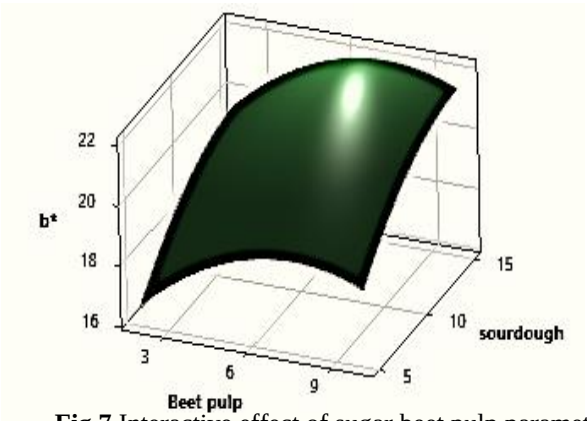


Fig 6 Interactive effect of sugar beet pulp parameters and time on brightness (a)

3-5-2 Redness index (a*) and yellowness (b*)

With the increase of sugar beet pomace and sour dough, the amount of redness index decreased drastically, and with the increase of time, the redness index increased drastically (Figure 7). By increasing the amount of sugar beet pomace up to about 6%, the yellowness index also increased and then this index decreased. The greatest effect for this parameter is related to sourdough, which increased the yellowness index greatly with the increase in the percentage

of sourdough. Another influential factor that had a great effect on this parameter is related to time, with the increase of time, the amount of yellowness index increased at first, but then decreased drastically.



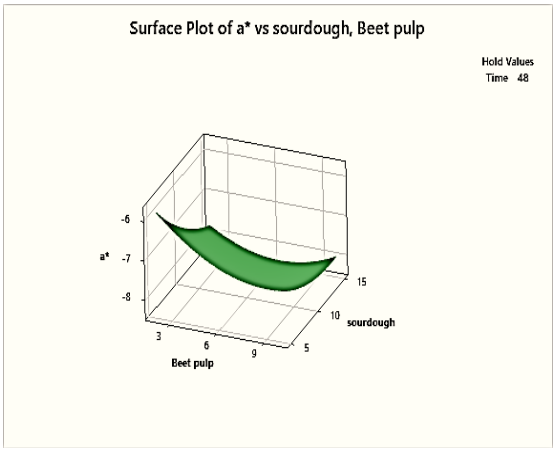


Fig 7 Interactive effect of sugar beet pulp parameters and time on redness index (a), jaundice index (b)

6-3- Examining the effect of variables on sensory evaluation

3-6-1 Color factor

As shown in figure (a-8), the color score of the samples increased with the increase of sugar beet pomace to about 8% and the increase of sour dough. The biggest effect on the color is related to the sour dough percentage parameter. As the percentage of sugar beet pomace increased to more than 8%, the color score also decreased.

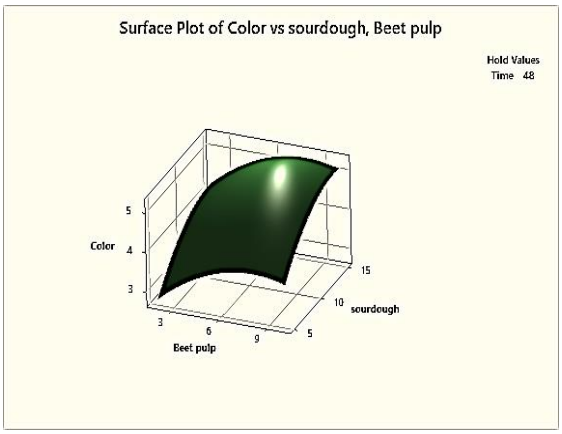


Fig 8 Interactive effect of sugar beet pulp and sourdough parameters on sensory evaluation (color factor) (a)

Yong et al. (2017), during a study, examined the quality characteristics of using fermented sourdough bread. They stated that the sample containing 20% sourdough showed the highest score in the sensory evaluation in color, aroma and appearance factors [32].

3-6-2- Texture factor

The influence of sourdough and sugar beet pomace variables on the texture factor is shown in figure (a-9).

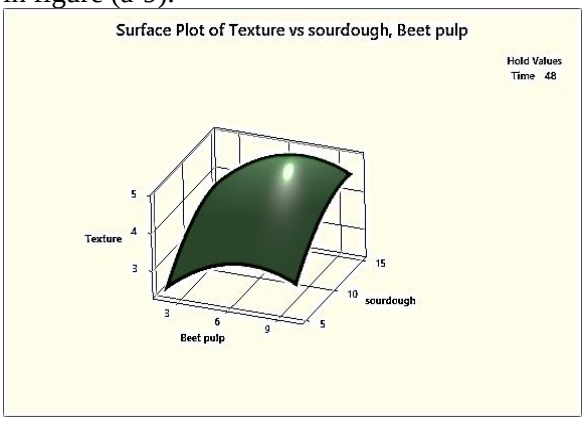


Fig 9 Interactive effect of sugar beet pulp and sourdough parameters on sensory evaluation (tissue factor) (a)

As can be seen, with the increase of sugar beet pomace and the increase of sour dough, the sensory index of the tissue increased, so that the sensory score of the tissue index was at the highest value with the increase of sugar beet pomace and the increase of the sour dough percentage up to 8%.

3-6-3-flavor factor

According to the results of variance analysis of aroma and taste, it was observed that factors of sugar beet pomace, sour dough have a significant effect on aroma and taste. With the increase of sugar beet pomace, at first, the amount of aroma and flavor gradually increased, but then it decreased more steeply, and with the

increase of the amount of sour paste, the aroma and flavor increased (Fig.a-10). Salim-ur-Rahman et al. (2007) reported in a study that the bread produced with sourdough by Lactobacillus bulgaricus strain had a better aroma and taste than the sample without sourdough [37].

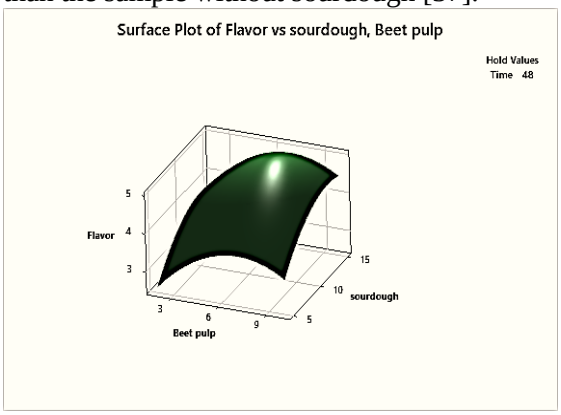


Fig 10 The interactive effect of sugar beet pulp parameters and sourdough on sensory evaluation (flavor factor) (a)

3-6-4-General acceptance invoice

In Fig (a11-), the interactive effect of sugar beet pomace and sour dough parameters on the overall acceptance of the samples has been shown. As can be seen, by increasing the amount of sugar beet pomace to about 9% and increasing sourdough to about 10% of the overall acceptance, the samples also increased and the biggest effect on the overall acceptance is related to the parameter of the percentage of sourdough. Sadeghi et al. (2015), in a report, stated that the baguette made from 10% barley flour sourdough with 45% kodomesma powder had the highest score in sensory evaluation. During their research, they stated that whole wheat flour sourdough had a positive effect on the sensory characteristics of baguette bread [38].

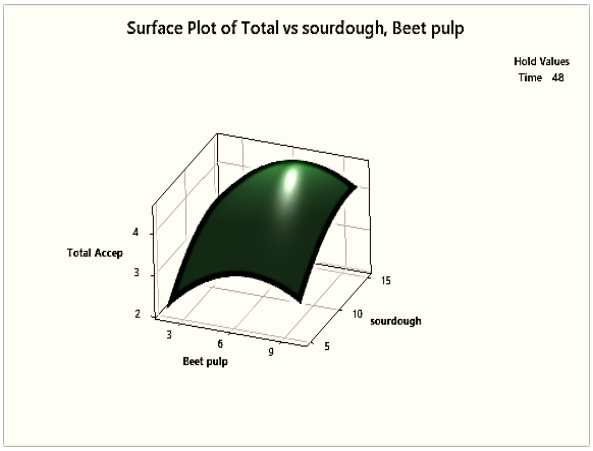


Fig 11 Interactive effect of sugar beet pulp and sourdough parameters on sensory evaluation (general acceptance factor) (a)

7-3-Optimization

Optimum levels for the independent variables of sugar beet pomace, sourdough and time were determined according to the desired values and target of the dependent variables using Minitab version 16 software. The total desirability was equal to 55 and the desirability of the dependent variables of stiffness, adhesion, breaking force, chewiness and gumminess were equal to 0.55, 0.78, 0.83, 0.53 and 0.60, respectively. Also, the optimal levels for the independent variables of sugar beet pulp, sour dough and time were 6.28, 7.32 and 88.24 hours, respectively.

4- General conclusion

In this research, the effect of adding sourdough at three levels of 5, 10, and 15% and sugar beet pulp at three levels of 2, 6, and 10% at three time intervals of 0, 48, and 96 hours in the formulation of bulky bread (baguette) was investigated in the form of the Bencken box statistical design. And for this purpose, parameters such as humidity, specific volume, water activity, hardness, breaking force, brightness L*, redness index a*, yellowness index b* and sensory characteristics such as color, texture and flavor were investigated. Based on the results, it was found that increasing the amount of sugar beet pomace and sourdough in the baguette bread formulation increased the moisture content, specific volume, general acceptability, and decreased the brightness and redness index. Also, the effect of sugar beet pomace compared to sourdough and time was

less on the yellowness index. And the sourdough factor had a greater effect on the aroma and flavor than the sugar beet pomace and time factors. Also, the results clearly showed that with the increase of sugar beet pomace, the amount of hardness decreased to more than 8%.

5- Resources

[1] Sanjari, S., Sarhadi, H., Shahdadi, F. 2018. Investigating the Effect of Spirulina Platensis Microalgae on Textural and Sensory Properties of Baguette Bread. Journal of Nutrition and Food Security, 3 (4): 218-225.

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بررسی کاربرد تفاله چغندرقند و خمیرترش بر کمیت و کیفیت نان باگت

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چکیده

نان یکی از مهم‌ترین مواد غذایی بر پایه گندم است که به‌عنوان یک منبع عالی انرژی و پروتئین نقش حیاتی در تغذیه مردم جهان دارد. بنابراین توسعه نان غنی‌شده یکی از راه‌های مؤثر در تأمین برخی از مواد مغذی موردنیاز مردم می‌باشد. هدف از این پژوهش، بررسی تأثیر تفاله چغندرقند و خمیرترش بر خواص فیزیکوشیمیایی، بافتی و حسی نان باگت بود. بدین منظور تفاله پرس شده چغندرقند و میزان خمیرترش به ترتیب در سه سطح ۲، ۶ و ۱۰ درصد و ۱۰،۵و ۱۵ درصد بر پایه وزن آرد در مرحله تهیه خمیر اضافه شد. پس از آماده‌سازی نمونه‌ها، آزمون‌های رنگ، بافت، رطوبت، فعالیت آبی، حجم مخصوص و ارزیابی حسی نان باگت انجام شد. نتایج نشان داد که افزایش میزان تفاله چغندرقند و خمیرترش در فرمولاسیون نان باگت باعث افزایش میزان رطوبت، حجم مخصوص و پذیرش کلی شد و a* کاهش یافت، همچنین تأثیر تفاله چغندرقند نسبت به خمیرترش بر b* کمتر بود. بنابراین استفاده از نمونه حاوی ۶درصد تفاله چغندرقند و ۱۰درصد خمیرترش به‌عنوان نمونه بهینه سبب بهبود ویژگی‌های کیفی نان باگت گردید.