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Evaluation of physicochemical properties of yogurt fortified with inactive baker's yeast

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ABSTRACT

Enrichment is one of the ways to increase the nutritional value of foods. In this research, enrichment of yogurt with Saccharomyces cerevisiae yeast was done as a cheap source of fiber, protein, vitamins and minerals to produce a functional food. Physico-chemical and sensory characteristics of enriched treatments were evaluated. Cow's fresh milk was mixed at 3 levels of fat (1.2, 1.8 and 3%) with yeast at 4 levels (0, 0.3, 0.6 and 0.9%) and used in preparing yogurt samples. The results showed that, in general, fat percentage, yeast percentage and duration of storage on pH and acidity changes were significant at the 95% confidence level. With increasing fat percentage, pH increased and acidity decreased. Increasing the percentage of yeast caused a decrease in pH and an increase in acidity. Synergy decreased with increasing the percentage of fat or yeast and also with increasing the duration of storage. The stifness of the tissue increased due to the increase of fat and decreased due with the increase of yeast. The highest level of tissue stifness was 0% in the yeast level and the lowest level was 0.9% in the yeast level. The amount of changes in fat, yeast and also the interaction of these two variables were significant and effective on the color index a* and b* with 95% confidence. However, only the variable of yeast percentage had a significant effect on the color index L*. Sensory evaluation results showed that only the variable of fat percentage had a significant effect on aroma, mouthfeel, internal texture, spoon acceptability and overall acceptance.

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1- Introduction

Food enrichment[1] It includes the addition of one or more nutrients in the processing of a food in order to prevent or correct the deficiency of one or more nutrients and increase the nutritional value of that food. Fortification is a proven, safe and cost-effective strategy to improve diets and to prevent and control micronutrient deficiencies [1-2]. The use of new biological resources such as yeast, mold and fungi as additives in food can be a solution for enriching food and producing ultra-beneficial foods.[2]) be These sources have good results both in terms of work methods, environmental considerations, high efficiency, profitability, and in terms of improvement and increase in nutritional value, and finally, they are very effective in improving the health of society [3-5]. Among protozoan protein cells, yeast is most suitable due to its superior nutritional quality. Yeasts have advantages such as larger size (and therefore easier harvesting), lower nucleic acid content, and higher levels of the amino acid lysine.[3] have more However, the most important advantage is the familiarity and food acceptability of yeast among humans because its use in traditional fermentations has a long history [6]. The most common type of yeast in terms of food grade[4] *Saccharomyces cerevisiae* It is also known as baker's yeast. Another advantage Yeast is its beta-glucan fiber content. Beta-glucan is a fibrous compound with probiotic properties. Other yeast species (including brewer's yeast) have been used in most of the studies conducted to enrich yogurt. For example, Pietroska[5] et al. (2009) showed that beta-glucan of brewer's yeast is effective in improving the stability of yogurt tissue, and the quality of sensory properties of yogurt is the same as compared to control yogurt only up to the level of adding 0.3% of beta-glucan [7]. The results of different studies on the sensory characteristics of yogurt after enrichment with yeast or mushroom beta-glucan are different and are influenced by the amount of beta-glucan used. in such a way that it has a negative effect (Santoz[6] et al., 2019) or had no effect (Raikus[7] et al., 2018) or to eliminate negative effects in sensory evaluation, recommending to use together with substances such as pectin (Antonseva[8] , 2019) has been [8-10].

Baker's yeast (which is also produced from sugar beet molasses) can be an abundant and inexpensive source for preparing a variety of beneficial foods. In this study, the effect of independent variables (fat, yeast and storage time) on the physico-chemical properties of yogurt (dependent variables: pH, acidity, hydration, texture and color) was investigated. At the same time, the sensory evaluation of yogurt treatments (as a basic product in the household food basket) was carried out.

2- Materials and methods

Pasteurized milk with 3.4% fat (measured by Gerber method), 13 acidity

[1]- Food fortification
[2]- Functional food
[3] -lysine
[4]- Food Grade
[5]- Piotrowska
[6] -Dos Santos
[7] - Things are going well
[8] -Antontseva

and 11.75 dry matter, as well as skimmed milk, were obtained from Greene Food Industry Company (Nishabor, Iran). Nonfat dry milk was purchased from Nasr Dalia Company (Mashhad, Iran). The starter used to prepare yogurt containing a mixture of Streptococcus thermophilus and Lactobacillus bulgaricus strains, especially for molded yogurt from the company(YoFlex-Express 1.0, Chr-Hansen, Denmark) it was prepared. Yeast: baker's yeast with a scientific name(*Saccharomayces cerevisiae*) It was purchased in 500g packages with the name of instant active dry yeast from Razavi Yeast Company (Mashhad, Iran). Other chemicals used by the companyMerck (Germany) was prepared.

1-2- Yeast preparation method

Yeast in the ovenBINDER Germany)) nv It was deactivated at 75°C for 150 minutes [11] and then crushed with a kitchen mill and sieved. (DAMAVAND) It was passed with 80 times 0.177 mm mesh. The resulting yeast powder was kept in the refrigerator for use in closed freezer plastic nylon and plastic containers with lids.

2-2- Producing our samples

First, by combining high-fat milk and fat-free milk, the desired milk fat was adjusted according to the test plan (Table 2-1-3). In the next step, the necessary amount of dry milk powder and yeast powder with a scale with an accuracy of 0.01(AND, Japan) Weighing and adding to the milk at the desired levels based on the test plan and stirring at a temperature of 55 degrees Celsius with a speed of 3 in the thermomix machine.(VORWERK Thermomix, Germany) It continued for 30 minutes until the powder compounds were dehydrated. For homogenization, the milk temperature was increased to 60°C and homogenization was performed at a pressure of 180 to 200 bar using a homogenizer (Behsaz Mashin, Iran). Homogenized milk was pasteurized at 90°C for 5 minutes and evaporated water was replaced by adding distilled water. The temperature of the pasteurized mixture is reduced to 43°C in water and ice environment and after adding the required starter, it is transferred to the incubator (Fan Azmagoster, Iran) at a temperature of 43°C and stored until the desired acidity is reached. became. Acidity andpH, was measured at 1.5, 2, 2.5, 3, 3.5 and 4 hours, and when the acidity reached 75 (Dornik), the samples were transferred to the cold room.

2-3- Physical and chemical tests

1-3-2- pH

pH Our examples are withpH Digital meter in accordance with the national standard of Iran No. 2852, measuring with 2 repetitions (on the 1st, 7th, 14th and 21st days after production) and by directly placing the electrode of the devicepH Meter(wtw inolab PH7310 Germany) It was measured inside the tissue of yogurt samples.

2-3-2- acidity

The acidity of the samples was measured by Dornick's method and by titrating 9 grams of each sample using 0.1 normal sodium hydroxide in the presence of phenolphthalein reagent and according to

The percentage of lactic acid was measured according to the national standard of Iran No. 2852 with 2 repetitions (on days 1, 7, 14 and 21 after production).

3-3-2- Watering(Syneresis)

Immediately after leaving each of the samples from the refrigerator with a temperature of 4 degrees Celsius, 20 grams of each sample inside the Falcon tube with a laboratory scale with an accuracy of 0.1(KERN 470, Germany) Weighing and in a centrifuge(Sigma 2-160 Germany) with a speed of 2500 rpm(g= 663) And it was done in 10 minutes with 2 repetitions (on the 14th and 21st days after production) [12]. After centrifugation, the separated water (liquid phase) inside the Falcon tubes was weighed after passing through filter paper. Watering percentage(S) It was calculated using equation 1.

Relationship 1:

S= (w1 / w2) * 100 (w1= weight of separated water andw2= initial weight of the sample)

4-3-2- texture

Hardness[9] The texture of the yogurt samples using the tissue analysis device(TPA LLOYD, AMETEK Company) According to the reverse extrusion method, it was evaluated with 2 repetitions (on the 14th day after production) [13]. Stiffness measurement with cell load[10] 5 N and threshold limit[11] 0.05 Newton, done. In this test, a cylindrical probe with a height of 50 mm and a diameter of 25 mm was used. This probe was set at a speed of 1 mm per second and up to a penetration depth of 75% of the height of the samples to penetrate into the sample. Tissue stiffness was calculated by the device software.

5-3-2- Color

The color measurement of our samples was done with one repetition and by image processing method. The image obtained in the formatpng It was saved on the computer, and then using the color space conversion plugin, the color space of the image fromRGB ToLAB Transform and finally average the values in each of the channelsL*, a*, b* Was calculated. Using image processing software(Image J) The color was evaluated [13]. To perform imaging, each sample was placed in a chamber or imaging box with a completely black wall covering, and after adjusting the appropriate and sufficient amount of white light and at the lowest amount of light reflection, by digital camera.(Nikon D3100, AF-S DX NIKKOR, Japan) Imaging was done.

6-3-2- Sensory evaluation

Sensory evaluation of yogurt samples after storage in the refrigerator at 4 degrees Celsius on the 14th day after production was done by judges. After leaving the refrigerator, each yogurt sample is subjected to a 9-point hedonic test (score 1: extremely bad and score 9: extremely good) to check (color, taste, aroma, mouthfeel, internal texture, spoonability and acceptance) Kelly) was provided to the judges. Also, in this test, the judges expressed their opinion as yes or no by answering the question (Do you think this product is worth buying?).

7-3-2- Test plan and statistical analysis

[9] - Firmness
[10] -Load Cell
[11] - Trigger

Experiments with completely random design in factorial format including three factors: added yeast percentage at four levels (0, 0.3, 0.6 and 0.9), fat percentage at three levels (1.2, 1.8 and 3) and maintenance time (testspH and acidity at time intervals 1, 7, 14 and 21 after production, watering test at time intervals 14 and 21 after production and texture, color and sensory evaluation tests were performed on day 14 after production).

Results for the data measured during the retention time, by fitting the quadratic polynomial model with feedback elimination.[12] and drawing 3D diagrams by softwareDesign Expert Version 10 was done. The results of the tests performed without the effect of time, with the analysis of variance method and softwareMINITAB Done. Comparison of means by methodTuckey It was done at a confidence level of 95%.

3. Results and Discussion

1-3- pH

The results of analysis of variance (Table 1 of the appendix) of the effect of process variables on the characteristicspH Yogurt indicates significance (0.05). ($p \leq$The model is predictive. Based on this model, fat percentage, yeast percentage and duration of storage changespH It is significant at the 95% confidence level and affects the model. The results show that with increasing fat percentage,pH increases, but with an increase in the percentage of yeast,pH decreases (Figure 1).

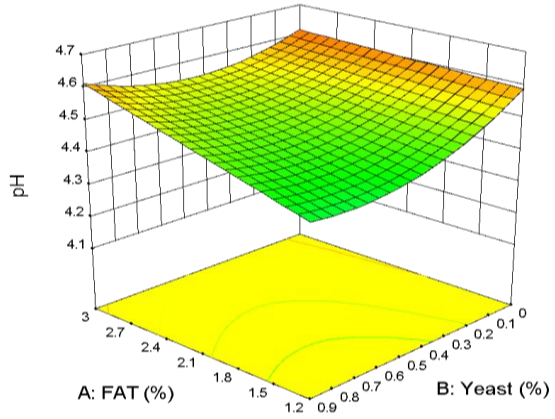

Figure 1- The effect of fat and yeast contents on pH

IndicatorpH It depends on the amount and speed of lactose fermentation and the acidity factor, it can also be affected by the buffer materials in the process environment [14]. yeast*Saccharomyces cerevisiae* As a prebiotic source, it contains nutritious compounds, fiber as well as beta-glucan. By increasing the percentage of yeast, more nutrients are available to the starter bacteria. Initiating bacteria can be more active with more and easier access to the nutrients they need, and as a result, the process of producing lactic acid, carbon dioxide and organic acids from lactose is carried out more intensively, and thereforepH decreases [15]. The presence of yeast, due to having a different amino acid profile compared to milk and the presence of these substances in the immediate vicinity of the initiator bacteria, probably causes the metabolic activity of the bacteria to occur at a faster rate and with the production of acid, the amount of acid decreases.pH create more during fermentation. Also, using different proportions of beta-glucan (as a fat substitute) can reducepH be [16]. The results of the present research with the results of

[12]- Backward Elimination

Niamah study[13] et al. (2017) is consistent. Their findings showed that by adding yeast*Saccharomyces boulardi* 1, 2 and 3 percent to yogurt,pH decreased in all levels [17]. In the study of Santos et al. (2019), yeast beta-glucan has a significant effect ($p<0.05$) on the valuespH It was not found in fat-free yogurt [8]. It should be kept in mind that the replacement of dry milk with yeast is also related to the reduction of the amount of lactose, and it is likely that the activity of the initiator bacteria is different from the growth conditions of the sample at a lower concentration of lactose.

cause of increasepH With the increase of fat, it can be considered the effect of fat on the activity of yogurt starter bacteria. So that high-fat yogurts, compared to low-fat yogurts, need more fermentation time to reach the same acidity, and this can be due to the difference in the type of starter bacteria used or the preparation conditions of yogurt treatments, as a result, it can reduce the metabolic activity of bacteria. The starter should be kept in the early days. Increasing the percentage of fat in normal yogurt samples (from 1 to 4%) with an effect on Activity initiators (for example, the activity of the lipase hydrolyzing enzyme) to achievepH It is effective in the final product during fermentation. At the same time, the growth of bacteria*Streptococcus thermophilus* It is done better in higher fat percentage.*Streptococcus thermophilus*It produces less acid compared to Lactobacillus bulgaricus. So in high fat percentages to reachpH It is desirable to increase the fermentation time [18]. Najaf Ghafari and Hosseini (2018) showed in their study thatpH High-fat yogurt samples were significantly higher than low-fat yogurt samples only at the end of the storage period. In addition, the type of initiator bacteria or the type and conditions of the production process can also be effective [19]. In the study of Mahdian et al. (2015), increasing the fat level in concentrated yogurt samples from 2.7% to 9% increasedpH but this effect was not significant. This lack of effect during the fermentation time was also observed for all fat levels. These researchers concluded that probably in the high solid matter percentage of acid ionization and ion productionH^+ It is prevented. An increase in the level of fat causes a decrease in the number*Streptococcus thermophilus* But it has a definite effect on the growth of bacteria*Lactobacillus bulgaricus* did not have [20].

2-3- acidity

The results of analysis of variance (attached table 2) The effect of process variables on acidity showed that the predictive model of acidity was significant (0.05). ($p \leq$ is. Based on this model, the variables of fat percentage, yeast percentage and storage time are significant on acidity changes at 95% confidence level. The results show that with the increase of fat percentage, the acidity decreases and with the increase of yeast percentage, the acidity increases (Figure 2). In the present research, the highest average amount

[13]- Niamah

Acidity (11.1) corresponds to the yogurt sample with 1.2% fat and 0.6% yeast on the 14th day after production and the lowest average amount of acidity (1.8) corresponds to the yogurt sample with 1.2% fat and without The yeast was on the first day of production.

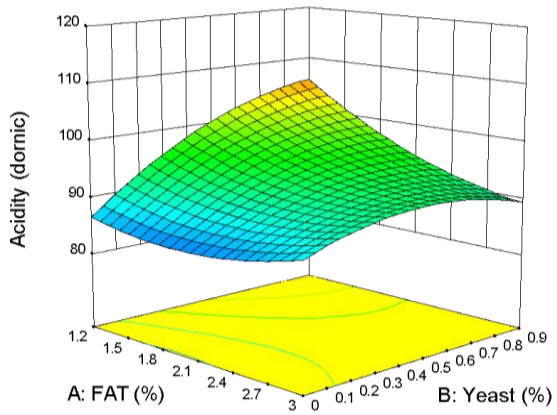

Figure 2- The effect of fat and yeast contents on acidity of yogurt.

In the yogurt fermentation process, the carbohydrates in the environment are converted into lactic acid as a result of the fermentation, as a result of which the acidity increases and the reduction of lactose starts at the same time as the starter is added to the environment and continues during the refrigeration operation. Also, by increasing the amount of beta-glucan of yeast (from 0.1 - 0.5%), the acidity in fat-free yogurt samples increases [10]. The acids produced during fermentation, which are mainly lactic acid produced by Streptococcus thermophilus bacterial strains and Lactobacillus bulgaricus during the fermentation process, are affected by the metabolic conditions of the bacteria in the process conditions, and the change in the formulation conditions of yogurt milk leads to a change in the behavior. These bacteria tend to decrease or increase metabolites, especially lactic acid. It seems that reducing the amount of milk powder and increasing the concentration of yeast, probably by reducing lactose and changing the balance of sugar and salt as well as the amino acid profile, has caused metabolic changes leading to an increase in acidity. The increase in yogurt acidity during cold storage can be due to microbial activity and enzymes produced during fermentation that convert residual carbohydrates (mainly lactose) into lactic acid.CO_2 and increases formic acid [21]. By adding Saccharomyces boulardi yeast at 1, 2 and 3% to the yogurt starter, Niamah (2017) showed that due to the breakdown of protein into peptides by the protease enzymes in the yeast, more nitrogen is available to the yogurt starter bacteria, and as a result, these bacteria grow. more and as a result the speed of acid production also increases. At the same time, the abundance of group vitaminsB In yeast, it helps the growth of bacteria. Therefore, the amount of lactic acid produced by starter bacteria can be affected by the amount and percentage of yeast. Also, in this study, the amount of volatile fatty acids[14] Compared to the sample of yogurt without yeast, it increased during 21 days of storage period [17]. Initiating bacteria in yogurt treatments can be more active with more and easier access to the nutrients they need, and as a result, the process of producing lactic acid, carbon dioxide and organic acids from

[14]- Total volatile fatty acids

lactose is carried out more intensively. Also bacterial growth*Streptococcus thermophilus* It is done better in higher fat percentage. Since high-fat yogurts need more fermentation time compared to low-fat yogurts to reach the same acidity, by increasing the fermentation time, the starter bacteria can be given the opportunity to increase the acidity by producing more acid in the fermentation process and at the same time as the fat increases. decrease [18].

3-3- Watering

The results of analysis of variance (Table 3 of the appendix) of the effect of process variables on the characteristics of yogurt during storage show that the predictive model of significant hydration (0.05 (p ≤ is. Based on this model, the percentage of fat, percentage of yeast and duration of storage are significant on the changes of irrigation at the confidence level of 95% and affect the model. The results show that by increasing the percentage of fat or yeast, water reduction decreases (Figure 3). In the present research, the highest average amount of liquefaction (33.55) corresponds to the yogurt sample with 1.2% fat, without yeast on the 21st day after production, and the lowest average amount of liquefaction (11.75) corresponds to the yogurt sample with 3% fat with Yeast was 0.9% on the 14th day after production.

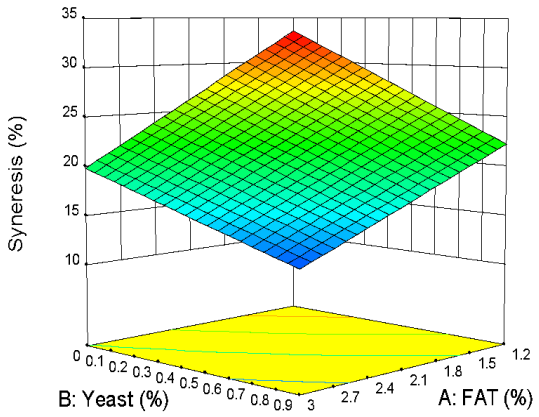

Figure 3- The effect of fat and yeast contents on syneresis

Watering in the yogurt product is a phenomenon affected by the rearrangement in the gel network structure of the yogurt protein mass caused by the density of the structure, the reduction of intra-network spaces, the appearance of hydrophobic areas and, as a result, the reduction of the water holding power in the network. Several factors influence this phenomenon. With the increase in the amount of fat, due to the creation of connected networks of fat globules, as well as the placement of caseins and whey proteins on the fat surface, a larger contact surface is created for the accumulation of water around the fat globules. For this reason, the product with higher fat can hold more water inside the structure. Tamim[15] And Barrantes[16] (1996) observed that yogurts containing fat have significantly less water. Similar results by Caminardes[17] et al. (2007) have been reported for the harmful levels of fat [22-23].

[15] - Tamime
[16] -Barrantes
[17] - In fireplaces

Enriching yogurt with beta-glucan can change both the structure of the network and its permeability and affect the process of hydration. A number of studies [14 and 21] have shown that due to the increase in the amount of some polysaccharides such as inulin and beta-glucan, the liquefaction of yogurt decreases. Therefore, the addition of such compounds can improve both network structure and permeability. The results of the present research also show that, in general, with the increase in the percentage of yeast, the water level decreases, which can be attributed to the high amount of glucans in yeast. On the other hand, adding yeast to the starter during the yogurt production process can also be a reason for increasing the percentage of water during the storage time. Because the increase of yeast leads to the increase of total solid particles and as a result increases the density of the gel network in yogurt, thus causing more water to escape from the gel network [17]. The results of the assessment of the amount of irrigation and the duration of storage in the present research are the same with the results of some studies [21 and 24]. Their findings showed that the amount of water in all yogurt samples increased during the storage period. The results of Santoz et al.'s study (2019) showed that yeast glucan is able to retain water during yogurt storage [8]. Brennan's study[18] and Todorica[19] (2008) also showed that the addition of carbohydrate-based fat substitutes (barley beta-glucan, guar gum and inulin) reduces dehydration [25].

[18] -Brennan

[19]- Tudor

4-3- texture

Texture is one of the physical characteristics of a product that comes from its structural elements and can be perceived by human senses. In fermented dairy products, having a soft and creamy texture is usually an advantage, and textural characteristics such as graininess, weak or looseness, or excessive stiffness are not desirable. The firmness of the tissue is related to various factors such as: primary milk compounds, the activity of the initiator bacteria and its type, the rate of the fermentation process, the ability to form a strong gel network, the type and percentage of the mixture that is chosen for enrichment. Results of analysis of variance Stiffness or maximum penetration force[20] It shows that the effect of fat percentage, yeast percentage and also the interaction effect of these two variables on the hardness of yogurt samples is significant (0.05 (p ≤is.

Table 1 shows the comparison of the average texture stiffness for different levels of yogurt fat percentage. In general, due to the increase in fat, the stiffness of the tissue has increased. From a statistical point of view, the characteristics of tissue stiffness are not different in samples with 3 and 1.8 fat percentage. The characteristics of tissue stiffness in samples with 1.8 and 1.2 fat percentages are not statistically different.

Table 1- The effect of fat contents on stiffness of yogurt

[20]- Penetration

Fat Content (%)	Average texture stiffness (N)
1.2	1.80 [b]
1.8	1.87 [ab]
3	2.14 [a]

Table 2 shows the average firmness of the texture for different levels of yogurt yeast percentage. In general, as a result of increasing the percentage of yeast, the stiffness of the texture decreases. From a statistical point of view, there is no difference in texture stiffness in samples with 0.9 and 0.6 yeast percentages, as well as in samples with 0.6 and 0.3 yeast percentages. The highest level of tissue stiffness was 0% at the level of yeast and the lowest was 0.9% at the level of yeast.

Table 2 – The effect of yeast contents on stiffness of yogurt

Yeast contents (%)	Stiffness (N)
0	2.41 [a]
0.3	2.05 [b]
0.6	1.72 [bc]
0.9	1.56 [c]

The amount of fat, due to its special viscoplastic properties and its interaction with the protein network, especially casein, and creating interconnected structures, plays a significant role in the textural characteristics of yogurt. With the reduction of the amount of fat, due to the vacuum caused by the absence of filling cells, the empty space is filled by yogurt serum, which facilitates the breaking of the three-dimensional structure of the mass gel and, as a result, changes its shape more easily during stress. Kaminardes et al. (2007) observed that the increase of fat from 0.9 to 6.6% caused an increase of 0.8 newtons in the force required to penetrate the gel tissue [23]. Yogurt texture can be affected by the amount of lactic acid produced during the fermentation process. Sakaro[21] et al. (2009) in evaluating the strength of probiotic yogurt samples found that the strength of probiotic yogurt is higher than normal yogurt and depends on the type of microorganisms present in the process. They showed that the absence of bifidobacteria in one of the treatments caused a decrease in tissue strength at the end of the storage period [26]. According to the study of Brennan and Todorica (2008), the addition of carbohydrate-based fat substitutes (barley beta-glucan, guar gum, and inulin) reduces water loss and improves the texture and rheological properties of low-fat yogurt. The improvement in product viscosity is probably related to the increase in total particles and solids in the formulation. Increasing the strength and stiffness of the gel makes the yogurt less prone to rearrangement inside the network, and as a result, water is reduced. The use of beta-glucan in low-fat yogurt formulations significantly increases the viscosity of the product. So that by increasing beta-glucan to 1% or more, the viscosity of the product improves significantly compared to low-fat and high-fat control yogurt samples. The combination of beta-glucan or inulin in the yogurt formula leads to an increase in product stiffness and consistency compared to both. The observed sample and the highest hardness and consistency in the enriched samples.

[21] - Saccaro

It is obtained with beta-glucan at the additive level of 2.5% [25]. Therefore, it can be said that yeast compounds such as beta-glucan and fibers can improve tissue stiffness. Also, due to the fact that they can enter the inter-tissue network and reduce the strength of the network, they also reduce the stiffness of the tissue.

3-5- Color indexes L*, a* and b*

Color is usually the first feature that is noticed in the appearance of food. The color of a food item can easily affect the taste, appetite and even sense of taste. Color also indicates the quality of food. Based on the results of the analysis of the effect of process variables on the color indexL*, the only variable of yeast percentage on the indexL* Significant effect (>0.001).P) had According to the results of the analysis of the effect of process variables on the color indexa*, the variables of fat percentage and yeast percentage, as well as the interaction of fat and yeast on the color indexa* And also on the color indexb*, with 95% certainty, they were effective and significant.

Comparison of average color indexL* In different percentages of yeast, it showed that the highest color indexL* It is related to the sample without yeast (more light) and the lowest is related to the sample with 0.9% yeast (less light). Due to the fact that the color of the yeast powder used is darker than the color of yogurt, therefore, in general, with the increase in the percentage of yeast, the brightness of the yogurt color has decreased (Table 3). Yoghurt is naturally white with high brightness due to its colloidal nature. The presence of yeast particles with the specific color of yeast causes the color of yogurt to change, which is expected. However, sensory tests showed that this amount of difference in brightness or darkening could only be detected by accurate color equipment such as imaging cameras and the sensory evaluator was not able to detect the color difference (data not presented). Average comparison for color indexa* At different levels of yeast (Table 6), it shows that the highest value of color indexa* It is related to the sample with 0.3% yeast (more green) and the lowest is related to the sample with 0.9% yeast (less green). Comparison of average color indexb* For different levels of yeast (Table 6) indicates that the highest color indexb* It is related to the sample with 9.9% yeast (more yellow and less blue) and the lowest is related to the sample with 0.3% yeast (less yellow and more blue). Data valuesa Andb It corresponds to two color balances, red-green and yellow-blue, respectively. However, due to the high values of L and the fact that our product is considered white, it is not possible to directly analyze two indices a and b. Due to the absence of a general trend with the increase in the amount of yeast and changes in these indicators, other factors such as texture density on the surface, reflection and refraction of light, caused by the presence of water on the surface of the material, are likely to be effective in achieving the results. In general, due to the closeness of the data values of the color components, it can be evaluated that the observed changes are mainly related to the surface and physical differences of the product, and yeast does not have a direct

effect on the color of the product due to its high solubility in milk.

Table 3- The effect of yeast contents on L*, a* and b* value

yeast percentage	L*	a*	b*
0	83.91 [a]	-20.14 [ab]	17.56 [b]
0.3	82.98 [a]	-22.96 [c]	14.86 [c]
0.6	79.31 [b]	-21.94 [bc]	16.32 [bc]
0.9	79.24 [b]	-18.74 [a]	19.31 [a]

Average comparison for color indexa* In different percentages of fat, it shows that the highest color indexa* It corresponds to the sample with 1.2% fat (more green) and the lowest is related to the sample with 3% fat (less green). Comparison of average color indexb* For different levels of fat, it shows that the most color indexb* It corresponds to the sample with 2.2% fat (more yellow and less blue) and the lowest is related to the sample with 3% fat (less yellow and more blue) (Table 4).

Table 4- The effect of fat contents on a* and b* value

Fat contents (%)	a*	b*
1.2	-22.34 [b]	18.58 [a]
1.8	-20.41 [a]	16.36 [b]
3	-20.09 [a]	16.10 [b]

Figure 4, the interaction effect of fat and yeast variables on the average color indexa* It shows in our samples. The lowest value is related to the sample with 3% fat and 0.9% yeast, and the highest value is related to the sample with 2.2% fat and 0.3% yeast. Figure 5, the average effect of the interaction of fat and yeast variables on the indexb* In yogurt samples, it shows that the lowest amount (less yellow and more blue) corresponds to the sample with 3% fat and 0.9% yeast, and the highest amount (more yellow and less blue) also corresponds to the sample with 2.2% fat and 3% yeast. It is 0.0%.

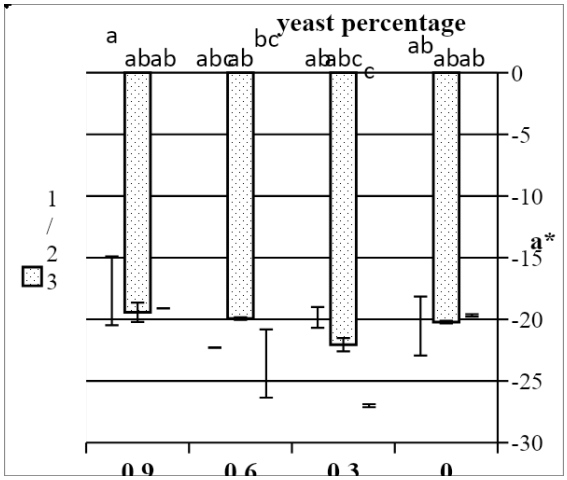

Figure 4- The interaction effect of fat and yeast contents on a* value

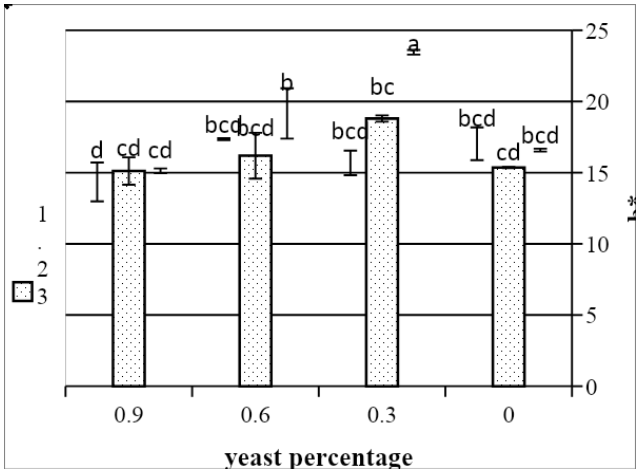

Figure 5- The interaction effect of fat and yeast contents on b* value

The present study showed that the color of the yeast powder used is darker than the color of yogurt, so in general, the whiteness of the color of yogurt has decreased due to the increase in the level of yeast. Increasing the percentage of fat as well as the percentage of yeast both decrease the green color and increase the red color in yogurt samples. In general, increasing the percentage of fat decreases the yellow color and increases the blue color in yogurt samples. Also, increasing the percentage of yeast increases the yellow color and decreases the blue color in yogurt samples. Considering the interaction effect of fat and yeast variables on the color indexb* (Figure 5) In total, the effect of adding fat compared to the effect of adding yeast on increasing the color indexb* It is more effective and the yellow color of yogurt is more influenced by the effect of fat. Najaf Najafi et al. (1400) considered the speed of fat homogenization as an effective and significant factor (<0.05).P) in the color indexL* They knew and showed that increasing the speed of homogenization leads to an increase in the color indexL* and the reason for that is more reflection of light and whiter color of yogurt due to the increase in the total level of fat caused by the increase in the amount of broken fat globules of yogurt due to the increase in the speed of homogenization [27]. Color index evaluation resultsL* Color in the present research with the results of the studies of Santoz et al. (2019) and Azkan[22] and Courtoldo[23] (2014) is aligned. In other words, adding yeast or glucan fibers to yogurt causes more darkness and also more yellowness of yogurt, and the reason for that is the dark (brown) color of yeast (or glucan fibers) [8 and 28].

6-3- Sensory evaluation

Based on the results of variance analysis, none of the variables of fat percentage or yeast percentage had a significant effect on the color and taste evaluated by the judges. Therefore, it can be concluded that according to the evaluators, the color and taste of different samples of yogurt do not differ significantly (0.05 (p >. Also, the results of the analysis of variance of the variables of aroma, mouthfeel, internal texture, spoon eating and overall acceptance showed that only the fat variable had a significant effect on these variables and the other variables had no significant effect (0.05). (p > are.

The average comparison results (Table 5) to investigate the effect of fat percentage

[22]-Ozcan

[23]- He survived

on aroma, mouthfeel, internal texture and spoonability showed that samples with 3% fat had the highest amount and 1.8% and 1.2% levels had no significant difference. In addition, no significant difference was found in the overall acceptance of samples of fat levels.

Table 5- The effect of fat contents on the sensory properties of yoghurt

Fat contents (%)	aroma	mouthfeel	texture	spoon acceptability	overall acceptance
1.2	6.47 a	6.76 b	7.03 ab	7.30 b	6.76 a
1.8	6.45 a	6.72 b	6.93 b	7.17 b	6.71 a
3	7.01 a	7.44 a	7.58 a	7.88 a	7.28 a

Improving the sensory properties of yogurt is largely dependent on improving its physicochemical properties. Shelf life conditions, increased metabolic activity of bacteria, lactose consumption, lactic acid production, breakdown of fatty acids and various combinations of fibers such as pectins, the type, percentage and properties of the fibers used can be effective in changing the above physicochemical properties during yogurt storage. An important point is the strength of the water retention capacity of the fiber, which can reduce the amount of watering and improve the texture, and this is due to the absorption of water by the fiber and the effect of the fiber on the viscosity of the yogurt. is attributed The storage time significantly affects the color, taste and flavor score of yogurts, which depends on the changes in the microbial load.pH And it has water supply [28 and 29]. Also, factors such as the slowing down of the movements of volatile compounds and the smell of alcohol due to the addition of enriching compounds and the color composition of these compounds can also affect properties such as aroma and color (directly) or taste (indirectly) of beneficial products. A number of studies have suggested that pectin [10] or inulin [21] can be used to eliminate or reduce the negative impact of some sensory properties caused by the addition of beta-glucan. The combination of barley and oat beta-glucan in low-fat dairy products can make the mouthfeel, acceptability and sensory characteristics of these dairy products similar to high-fat products [28].

7- General conclusion

As a dairy product, yogurt is a good source for enrichment. The food industry sector can play an important role in introducing super-beneficial foods by producing such products. Based on the results of this study, in general, taking into account the physico-chemical and sensory characteristics, yogurt enriched with baker's yeast (due to the cheapness, availability and nutritional value of yeast) can be a suitable option. Although this issue needs more investigation and research, especially in terms of acceptance at the community level.

thanking

Greene Neishabur Food Company (Research and Development Unit) is appreciated and thanked for its cooperation in the implementation of this research.

the attachment

Table 1 attached - The results of variance analysis of the effect of process variables on the pH characteristics of yogurt during storage

Analysis of variance table [Partial sum of squares - Type III]

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	72/0	6	12/0	20/18	< 0001/0	significant
A-FAT	11/0	1	11/0	40/16	0002/0	
B-Yeast	053/0	1	053/0	05/8	0070/0	
C-Time	40/0	1	40/0	94/60	< 0001/0	
AB	033/0	1	033/0	02/5	0306/0	
B^2	043/0	1	043/0	45/6	0150/0	
C^2	074/0	1	074/0	17/11	0018/0	
Residual	27/0	41				
Cor Total	99/0	47				

Table 2 attached - The results of variance analysis of the effect of process variables on the characteristics of yogurt acidity during storage

Analysis of variance table [Partial sum of squares - Type III]						
Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	12/2346	9	68/260	86/27	< 0001/0	significant
A-FAT	51/447	1	51/447	83/47	< 0001/0	
B-Yeast	77/689	1	77/689	72/73	< 0001/0	
C-Time	31/291	1	31/291	13/31	< 0001/0	
AB	92/384	1	92/384	14/41	< 0001/0	
AC	12/28	1	12/28	00/3	0911/0	
BC	05/31	1	05/31	32/3	0764/0	

A^2	54/60	1	54/60	47/6	0152/0
B^2	04/123	1	04/123	15/13	0008/0
C^2	62/170	1	62/170	24/18	0001/0
Residual	55/355	38	36/9		
Cor Total	66/2701	47			

Appendix Table 3 - The results of analysis of variance of the effect of process variables on the characteristics of yogurt water during storage

Analysis of variance table [Partial sum of squares - Type III]						
Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	86/870	5	17/174	49/59	< 0001/0	significant
A-FAT	43/544	1	43/544	96/185	< 0001/0	
B-Yeast	73/255	1	73/255	35/87	< 0001/0	
C-Time	82/18	1	82/18	43/6	0207/0	
AB	81/10	1	81/10	69/3	0707/0	
BC	15/22	1	15/22	56/7	0132/0	
Residual	70/52	18	93/2			
Cor Total	56/923	23				

5- Resource

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بررسی ویژگی‌های فیزیکوشیمیایی ماست غنی‌شده با مخمر نانوایی غیر فعال

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چکیده

غنی‌سازی، یکی از راه‌های بهبود ارزش غذایی غذاها است. در این پژوهش غنی‌سازی ماست با مخمر ساکارومایسیس سرویزیه به عنوان منبعی ارزان قیمت از فیبر، پروتئین، ویتامین و مواد معدنی برای تولید یک غذای فراسودمند صورت گرفت. ویژگی‌های فیزیکی - شیمیایی و حسی تیمارهای غنی‌شده ارزیابی شد. شیر پاستوریزه گاو در ۳ سطح چربی (۱/۲، ۱/۸ و ۳ درصد) با مخمر در ۴ سطح (۰، ۰/۳، ۰/۶ و ۰/۹ درصد) مخلوط و در تهیه نمونه‌های ماست استفاده شد. نتایج نشان داد به طور کلی درصد چربی، درصد مخمر و مدت زمان نگهداری بر تغییرات pH و اسیدیته در سطح اطمینان ۹۵ درصد معنی‌دار بود. با افزایش درصد چربی، pH افزایش و اسیدیته کاهش یافت. افزایش درصد مخمر، باعث کاهش pH و افزایش اسیدیته شد. آب‌اندازی ماست با افزایش درصد چربی و یا مخمر و همچنین با افزایش مدت زمان نگهداری کاهش داشت. سفتی بافت در اثر افزایش چربی افزایش داشت اما در مجموع در اثر افزایش درصد مخمر کاهش داشت. بیشترین مقدار سفتی بافت (۲/۴۱) در سطح مخمر صفر درصد و کمترین مقدار آن (۱/۵۶) در سطح مخمر ۰/۹ درصد بود. میزان تغییرات چربی و مخمر و همچنین برهمکنش این دو متغیر، بر شاخص‌های رنگی *a، *b با اطمینان ۹۵ درصد تاثیرگذار و معنی‌دار بودند. اما بر شاخص رنگی *L، تنها متغیر درصد مخمر تاثیر معنی‌دار داشت. نتایج ارزیابی حسی نشان داد تنها متغیر درصد چربی بر رایحه، احساس دهانی، بافت داخلی، قاشق‌پذیری و پذیرش کلی تاثیر معنی‌دار داشته است.