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Study on the Physicochemical Properties of Synbiotic UF-Cheese Containing demineralized Ultrafiltrated Whey powder and lactulose During Storage Period

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ABSTRACT

Ultrafiltrated (UF)-white cheese is almost a new generation of white-cheeses that is produced throughout ultrafiltration process. This cheese has a soft and spreadable texture and is distributed in the market after a short storage period. Lactulose is a prebiotic compound that in addition to its positive effect on the growth of probiotic bacteria, its beneficial health effects on human well-being is proved. In the current research, synbiotic cheese samples were produced with the usage of demineralized ultrafiltrated whey powder (DUWP) at 3 levels of 0, 1 and 2%, lactulose at 2 levels of 0 and 1%, and *bifidobacterium bifidum* as probiotic bacteria. Experimental samples were analyzed and tested for physicochemical analysis including pH, acidity, moisture, syneresis, fat, protein and soluble nitrogen to total nitrogen ratio (TSN/TN) during 60 days of storage at 4 ◦C. Results revealed that addition of DUWP and lactulose, except for protein, had significant effects on the other tested parameters. In addition, the time of storage period had noticeable impact on all the examined physicochemical properties (P<0.01). Based on the results of this study, it was found that the best UF-white synbiotic cheese could be produced with the usage of 1% of each DUWP and lactulose powders.

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1. Introduction

Cheese is the general name of a group of fermented foods made from milk. Today, different types of cheese with different aromas and flavors are produced all over the world [1]. Cheese as a dairy product has played an important role in human nutrition for centuries. The diversity of cheeses produced in the world today and their high nutritional value has made cheese to have a special place in the diet of many nations [2]. It is believed that cheese evolved in the "Fertile Crescent" between the Tigris and Euphrates rivers in Iraq, about 8000 years ago during the "Agricultural Revolution" when certain plants and animals were domesticated [3].

White cheese is one of the most important types of cheese that can be made by two traditional methods or ultrafiltration[1]) it is produced. Ultra-refining is a process that selectively separates macromolecules with a molecular weight of 1000 to 200,000 daltons from the solvent and soluble solutes. Cross-flow ultrafiltration on the membrane surface at relatively low pressure (less than 1000 kPa) produces a permeate containing water, lactose, soluble minerals, non-protein nitrogen and water-soluble vitamins from milk. Meanwhile, it separates and collects proteins, fats and colloidal salts from passing materials in another compartment [4]. Iranian white cheese by ultra-refining method has the highest per capita consumption in Iran. This cheese is classified in the category of fresh cheeses and has a soft and rubable texture; Because immediately after production, it enters the consumption market without any processing period. During the storage period, various biochemical reactions occur in cheese, which causes changes in the quality of the product. During the last 35 years, this cheese has drawn a lot of attention to the use of ultra-refining method all over the world [5].

The term superfood was first mentioned in 1980 in Japan, which refers to processed foods containing substances that, in addition to being nutritious, also help specific body functions. During the last few decades, the attention to the science of nutrition (the effect of diet on health and well-being) has been increasingly noticed. Paying attention to the role of food as food-medicine has led to the design of new and healthier foods that reduce the risk of many chronic diseases. Foods designed in this way, functional foods[2] or they are called ultra-beneficial, which have health benefits compared to usual products [6].

The current trend of consumer behavior shows that consumers are more inclined towards practical foods that have a positive effect on the host's health. Probiotics are useful microorganisms that, if consumed in sufficient amounts, in humans or animals, by affecting the microbial flora of the body, cause beneficial effects on the health of the host. Most of the probiotics belong to a large group of the main bacteria of human intestinal microbial flora and have a harmless symbiotic life there [7]. In order to synergize the effect of probiotics, prebiotics are used in food products. Prebiotic is a substrate that is selectively used by host microorganisms and is beneficial for health. The combination of probiotics and prebiotics is known as a symbiotic combination. "Synbiotic" is the term used for probiotic foods containing prebiotic compounds. These compounds help to improve the viability of probiotics and spread the health benefits in the host's body [8]. In any case, in the production of pragmatic products, one should pay attention to other factors such as nutritional value and sensory properties of the product; Because

[1]- Ultrafiltration

[2]- Functional food

the quality of taste and texture of the product plays an important role in the consumption of these food products. Today, blue cheese proteins have been considered due to their high biological value and the improvement of the sensory quality of processed cheese [9, 10].

Blue cheese is a by-product of cheese production. Blue cheese is a relatively diluted product with a total solid content of about 5-6%, which is obtained in both sweet and acidic forms during cheese production. In addition to using cheese in fresh or powder form, due to the development of different separation methods such as diafiltration membrane separation methods.[3] (DF), vibrating shear processing system[4] (VSEP) and osmosis, different products of water cheese (especially the sweet type) are produced and marketed [11]. whey protein concentrate ([5]WPC), whey protein isolate ([6]WPI), hydrolyzed whey protein ([7]WPH), as well as various purified components of cheese protein such as alpha-lactalbumin and beta-lactoglobulin are among these products. In addition to the use of these products in special diets such as athletes, the use of fresh or processed cheese in the production of various dairy products such as cheese[12], yogurt [13], kefir [14], ice cream [15] and also non-dairy products such as flat bread [16], bulky bread [17] and edible films [18]Is taken into consideration. However, unlike the mentioned whey, today a significant volume of afterwater or whey resulting from the ultra-refining process (permeate) is created during the preparation of cheese or the production of milk protein powder, the composition of which is completely different from the usual whey. Compared to the powder prepared from sweet cheese, the powder prepared from Permit has a relatively lower quality due to more lactose and salts and the presence of small amounts of proteins from the cheese. Therefore, in order to increase the usability of Permit powder in the formulation of food products, the amount of salts They reduce it, and in this way, a product called ultra-refined cheese powder (Permit) with reduced solutes.[8]DUWP) is produced and marketed. Due to the high lactose and the presence of suitable amounts of solutes and the acceptable amount of serum proteinsDUWPIt seems that it can be used in the production of various food products, especially synbiotic food products.

Lactulose was first synthesized in 1930 from lactose following an alkaline isomerization reaction. At the end of the 20th century, the bifidogenic effect of lactulose was reported for the first time. Prebiotics including lactulose, inulin and oligofructose are considered as bifidogenic factors [19]. Lactulose is a prebiotic and is used as an effective medicine to treat diseases such as chronic constipation, hepatic encephalopathy, complications of liver diseases, inflammatory bowel diseases, cancer prevention, immunology and anti-endotoxin effects [20]. Lactulose can also promote the growth of some gastrointestinal health-promoting bacteria, e.g*Bifidobacterium* And*Lactobacillus* increase and the growth of pathogenic bacteria such as*salmonella* to restrain [21]. Therefore, lactulose is considered as a suitable prebiotic compound in the production of synbiotic products such as feta cheese [22] and yogurt [23].

[3]- Diafiltration

[4]- Vibratory shear-enhanced processing system

[5]- Whey Protein Concentrate

[6]- Whey Protein Isolate

[7]- Whey Protein Hydrolysate

[8] -Demineralized ultrafiltrated whey powder

has taken. Therefore, the current research was conducted with the aim of investigating the effect of adding lactulose andDUWP Synbiotic ultra-refining was performed on the physicochemical characteristics of cheese.

2- Materials and methods

1-2- Materials used

Fresh cow's milk of appropriate quality was used to produce ultra-refined cheese samples. Mesophilic starter powdersCHOOZIT 230 (Contains a mixture of bacteria*Lactococcus lactis subspecies Cremoris*And*Lactococcus lactis subspecies lactis*) and thermophilic starterYo-Mix 532 (contains*Streptococcus thermophilus* And*Lactobacillus delbruecki subspecies bulgaricus*) from Germany's Danesco company and probiotic starter powder containing bacteria*Bifidobacterium Bifidium subsp*From Christian Hansen Company[9] Denmark was purchased. The mentioned powders are of the typeYOU and was kept at -18 degrees Celsius until use. Brand name rentChey-Max It was purchased from Christian Hansen, Denmark. Permit powder or wastewater from ultra-purification of milk with reduced solutes (DUWP) used in this research was purchased from Baltic Food Industry Company (Russia). Powder ingredients DUWP It included 3.3% moisture, 3.8% protein, 88.5% lactose, 3.5% ash, and 0.9% fat. Lactulose was purchased and used from Sigma (USA). Other chemicals used in this research were of high quality and mostly purchased from Merck, Germany.

2-2- Cheese production method

Farapaloude cheese was produced in Pegah dairy factory of Shush Khuzestan according to the method of Torabi et al. [10] and Jovindeh et al. After two stages of bactofugation of the received raw milk, the process of pasteurization and ultra-refining was carried out. After passing through the ultra-refining membrane, the milk is permeated into two parts[10] Or the passage part (cheese juice) and retentate[11] Or it was divided by 31% of solid matter. After adding the powderDUWP (zero levels, 1 and 2 percent,W/V) and lactulose (zero and 1% levels,W/V) in addition, the homogenization process at 70 bar pressure by the model homogenizer deviceJHG-Q60-P60 (Ronghe machinery, China) was done. It should be noted that the levels of powdersDUWP and lactulose in this research were determined based on preliminary tests. Next, Natraveh went to a plate pasteurizer and was pasteurized up to 75 degrees Celsius for 15 seconds. Then, mesophilic and thermophilic starter powder each at the rate of 0.025% and probiotic starter powder at the rate of 0.05% along with microbial rent (obtained from*Aspergillus niger* variety*Awamori*) was added to Natrave by 0.03%. The amounts of starter bacteria and probiotics were chosen in such a way that the number of each of them in the cheese was minimalLog cfu/g 10^8 reach After placing Narava in 400g cheese containers, the packages entered the coagulation tunnel at a temperature of 31-30 degrees Celsius, and after exiting the tunnel and coagulation of the cheese, parchment paper was placed on the surface of the cheese. At the end, 2% of salt (weight/weight) was added to the containers containing cheese and the packages were sealed with aluminum foil. Next, the cheese packages were kept in a greenhouse at a temperature of 25-27 degrees Celsius and after 18-24 hours and ripeningpH The samples were transferred to the cold room with a temperature of 5 degrees Celsius. In this research, the samples of Iranian white cheese are extrapolated with probiotics (without lactulose powder andDUWP) as a control sample with synbiotic cheese samples (containing different amounts of

[9]- Chr. Hansen

[10]- permeate

[11]- retention

lactulose powder and DUWP) were evaluated on days 1, 30 and 60 in terms of physicochemical characteristics.

3-2- Physicochemical tests

In this research, the amountpH and acidity in accordance with the standardAOAC [25] and using the devicepHDigital meter (model 827, Metrahm, made in Switzerland) was measured. The amount of acidity by titrating the amount of lactic acid in a diluted solution of cheese samples with soda solution 1/۰ Normal and measured in the presence of phenolphthalein and reported as Dornick's degree. The moisture content of the samples was measured by soaking at 105 degrees Celsius for about two hours until a constant weight was reached, and the degree of hydration of the cheese samples was measured by the ratio of the weight of the separated cheese juice to the weight of the cheese [16]. The amount of fat by the Gerber method according to the method of Egan et al. [26] and the amount of total protein through the product of the amount of nitrogen obtained by the Keldahl method in a factor of 38. ٦According to the methodAOAC [25] was measured. The measurement of nitrogen soluble in water compared to total nitrogen was measured according to the method of Kuchero and Fox [27] in order to determine the amount of proteolysis. In this method, first, 20 grams of cheese sample was mixed with 80 milliliters of distilled water and homogenized. ThenpH It by the solution of a normalHCl OrNaOH It was set at 4.6 and after 30 minutes at room temperature, againpH It was set on 4/6. Next, the samples were heated in an oven at a temperature of 40 degrees Celsius for 30 minutes, then they were centrifuged at 3500 rpm for 30 minutes. After separating the supernatant solution with Whatman No. 42 filter paper, the separated dissolved nitrogen was measured by the Keldahl method [27].

4-2- Statistical analysis

In this research, according to two variables lactulose (at two levels) and powderDUWP (at 3 levels), 6 cheese treatments were produced and cheese samples were compared with each other in terms of physicochemical characteristics during two months of storage (at intervals of 1, 30 and 60 days after production). According to the production of cheese samples in 3 repetitions, a total of 54 samples were produced. Results by completely random design in factorial format with the help of statistical programSPSS (SPSS Inc.، Chicago, 20th edition) analysis and average results were compared with the help of Duncan's test at the 5% level. Excel 2016 software was used to draw graphs.

3. Results and Discussion

3-1- ChangespH and acidity

The results of the effect of adding sweet cheese powder with reduced solutes and lactulose on the characteristicspH and the acidity of different samples of Farapaludhi Synbiotic Iranian white cheese during 60 days of storage at 4 degrees Celsius are presented in Tables 1 and 2. As can be seen in tables 1 and 2, adding powderDUWP Better treatment causes a significant decrease and increase in the amountpH and acidity. In the case of lactulose, although its addition causes a significant decreasepH but the acidity of cheese was not significant (0.05).<*P*). On average,pH Ultra-refined cheese samples containing 0, 1 and 2% powderDUWP 48.48, 4.44 and 4.39 and its acidity was determined as 27.89, 26.90 and 91.07 Dornic degrees. LevelpH Ultra-refined cheese samples containing 0 and 1% of better quality lactulose powder 4.46 and 4.42 and its acidity

Better quality was determined as 87.89 and 90.53 degrees of Durnik. DecreasepH and increased acidity as a result of increased lactulose in yogurt [23] and fermented milk [28] has already been reported.

Also, with increasing storage time, the amountpH And the acidity of the better cheese samples decreased and increased significantly (<0.001).*P*). According to table 1, during 60 days of storage, the lowestpH (4.24) and the highest acidity (99.92) related to the sample containing 1% lactulose powder and 2% powderDUWP Was; While the lowest acidity (99/78) and the mostpH (4/67) was observed in the control sample at the beginning of the storage period. In connection with the downward trendpH Observed during the storage period for all 6 samples produced, Olivera et al. [28]of theIn the case of probiotic low-fat milk containing lactulose and Buriti et al. [29] also reported similar results for synbiotic raw cheese. Kardarlelia et al. [30] also reduced the amount in accordance with the findings of this researchpH reported in synbiotic Swiss cheese during a storage period. These researchers considered ripening in fermented products such as cheese to be a natural process caused by the production of lactic acid and organic acids by starter bacteria and probiotics. They stated that due to the presence of prebiotic compounds, the population of probiotic bacteria as well as starter bacteria increases and this causes an increase in the production of lactic acid and a decrease in the amountpH In the samples, synbiotic cheeses are used. Abderrabo et al. [31] regarding the synbiotic Domiati cheese by presenting results similar to the findings of this research, the decreasing trend of the amountpH confirmed Aghajani et al. [32] the effect of prebiotic compounds on yogurt and Islam et al. [33] about synbiotic cheddar cheese also reported results similar to the results of this research. Sarwar et al [34] Also increase and decrease aciditypH In yogurt, during the storage period, they stated that it is caused by microbial activity and enzymes produced during fermentation; Because the passage of time causes the conversion of remaining carbohydrates (mainly lactose) into lactic acid, carbon dioxide and formic acid.

According to Table 1, there is no interaction between the tested variablespH And acidity was not observed.

Table 1. The results of analysis of variance (ANOVA) of the effect of demineralized ultrafiltrated whey powder (DUWP) and lactulose powder on physicochemical characteristics of synbiotic ultrafiltrated cheeses during 60 days storage at 4 ˚C

		Mean Square						
Treatments	**df**	**pH**	**Acidity**	**Moisture**	**Syneresis**	**Protein**	**Water Soluble Nitrogen/Total Nitrogen**	**Fat**
DUWP	2	0.039^{**}	14.640^{*}	16.555^{***}	0.526^{NS}	0.096^{NS}	1.475^{**}	0.394^{*}
Lactulose	1	0.022^{*}	5.789^{NS}	10.454^{***}	0.368^{NS}	0.154^{NS}	1.732^{**}	0.432^{*}
Storage Time (Day)	2	0.394^{***}	1616.987^{***}	9.332^{***}	11.593^{***}	0.368^{***}	30.345^{**}	6.104^{***}
DUWP× Lactulose	2	0^{NS}	0.293^{NS}	0.054^{*}	0.005^{NS}	0.009^{NS}	0.025^{NS}	0.004^{NS}
DUWP×Storage Time	4	0.001^{NS}	0.483^{NS}	0.003^{NS}	0.016^{NS}	0.005^{NS}	0.162^{NS}	0.075^{NS}
Lactulose ×Storage Time	2	0^{NS}	0.920^{NS}	0.043^{NS}	0.071^{NS}	0.005^{NS}	0.143^{NS}	0.051^{NS}
DUWP× $Lactulose$ ×	4	0.0001^{NS}	0.238^{NS}	0.007^{NS}	0.012^{NS}	0.003^{NS}	0.020^{NS}	0.009^{NS}

Storage Time		s				s		s
error	36	0.004	3.928	0.109	0.169	0.057	0.090	0.087

NS, *, ** and *** respectively indicate: non-significance, and significance at p<0.05 and p<0.01, p<0.001 levels.

Table 2. Physicochemical characteristics of synbiotic ultrafiltrated cheeses containing demineralized ultrafiltrated whey powder (DUWP) and lactulose during 60 days storage at 4 ˚C

Characteristics	Storage Time (Day)	*P_0L_0 (Control)	P_1L_0	P_2L_0	P_0L_1	P_1L_1	P_2L_1
pH	1	4.67±0.06^{Aa}	4.62±0.07^{Oops}	4.56±0.06^{Oops}	4.64±0.07^{Oops}	4.59±0.04^{Oops}	4.52±0.08^{Ab}
	30	4.45±0.02^{Not}	4.42±0.03^{Chapter}	4.39±0.02^{Chapter}	4.41±0.03^{Chapter}	4.37±0.09^{Chapter}	4.34±0.03^{Bb}
	60	4.37±0.08^{Not}	4.34±0.08^{Not}	4.29±0.10^{Not}	4.35±0.08^{Not}	4.30±0.09^{Not}	4.24±0.07^{Not}
Acidity (◦D)	1	78.99±1.83^{That}	79.80±2.17^{That}	80.40±1.82^{That}	79.02±2.01^{That}	80.15±2.50^{That}	80.40±2.66^{That}
	30	91.00±2.77^{Not}	91.87±3.01^{Not}	93.13±1.92^{Not}	91.50±2.33^{Not}	93.17±2.59^{Not}	94.18±2.10^{Not}
	60	97.25±0.74^{Ab}	98.03±0.98^{Ab}	98.40±1.22^{Oops}	97.84±0.64^{Ab}	98.56±0.41^{Oops}	99.92±1.13^{Aa}
Syneresis (%)	1	1.51±0.30^{Not}	1.57±0.31^{Not}	1.70±0.27^{Not}	1.71±0.36^{Not}	1.84±0.33^{Not}	1.97±0.45^{Not}
	30	2.96±0.52^{Aa}	3.24±0.29^{Aa}	3.50±0.44^{Aa}	3.14±0.52^{Aa}	3.30±0.56^{Aa}	3.42±0.55^{Aa}
	60	2.58±0.41^{Aa}	2.80±0.34^{Aa}	2.97±0.33^{Aa}	2.80±0.32^{Aa}	2.95±0.26^{Aa}	3.18±0.56^{Aa}
Moisture (%)	1	66.99±0.30^{Aa}	65.08±0.36^{Ab}	64.08±0.31^{And}	65.02±0.23^{Ab}	64.20±0.34^{And}	63.19±0.33^{Ad}
	30	64.69±0.29^{Not}	63.67±0.30^{Bb}	62.72±0.38^{Bc}	63.67±0.34^{Bb}	62.74±0.26^{Cc}	61.79±0.30^{Bd}
	60	65.00±0.31^{Not}	63.92±0.45^{Bbc}	62.99±0.52^{Bd}	64.08±0.38^{Bb}	63.35±0.22^{Bcd}	62.28±0.12^{Bc}
Protein (%)	1	11.85±0.25^{Aa}	11.87±0.25^{Aa}	11.84±0.25^{Aa}	11.87±0.13^{Not}	11.74±0.24^{Aa}	11.71±0.35^{Aa}
	30	12.37±0.20^{Aa}	12.33±0.21^{Aa}	12.20±0.25^{Aa}	12.28±0.22^{Aa}	12.12±0.30^{Aa}	12.06±0.30^{Aa}
	60	12.02±0.31^{Aa}	11.93 ±0.21^{Aa}	11.86±0.18^{Aa}	11.93±0.22^{ABa}	11.83±0.13^{Aa}	11.77±0.11^{Aa}
Water Soluble Nitrogen/Total Nitrogen (%)	1	5.97±0.16^{Bb}	6.09±0.21^{Cb}	6.29±0.25^{Cab}	6.12±0.12^{Bb}	6.26±0.17^{Chapter}	6.52±0.22^{That}
	30	7.72±0.20^{Ab}	7.89±0.19^{Chapter}	8.12±0.34^{Chapter}	8.04±0.29^{Oops}	8.31±0.32^{Aa}	8.46±0.39^{Not}
	60	8.06±0.31^{And}	8.41±0.35^{Abc}	8.83±0.36^{Ab}	8.49±0.46^{Abc}	8.81±0.50^{Ab}	9.58±0.29^{Aa}
Fat (%)	1	15.92±0.28^{Not}	15.92±0.28^{Aa}	15.85±0.25^{Aa}	15.91±0.28^{Aa}	15.84±0.20^{Aa}	15.76±0.23^{Aa}
	30	16.48±0.24^{Aa}	16.36±0.21^{Aa}	16.24±0.28^{Aa}	16.26±0.41^{Aa}	16.13±0.32^{Aa}	16.03±0.41^{Aa}
	60	15.55±0.25^{Not}	15.26±0.38^{Chapter}	14.90±0.26^{Bb}	15.19±0.18^{Chapter}	14.98±0.19^{Chapter}	14.76±0.44^{Bb}

P0, P1 and P2 are 0, 1 and 2% levels of whey permeate and L0 and L1 are 0 and 1% lactulose, respectively. Different small and capital letters indicate significant differences (p<0.05) in each row (treatments) and column (days) for each cheese characteristics, respectively.

2-3- humidity changes

The results of the changes in the moisture content of the produced cheese samples due to the increase in ultra-refined cheese powder with reduced salts and lactulose during 60 days of storage can be seen in Tables 1 and 2. Based on the obtained findings, adding powderDUWP and lactulose caused a significant decrease in the moisture

content of the samples (<0.001).*P*). On average, the moisture content of the samples of Farapaludhi cheese containing 0, 1 and 2 percent powderDUWP It was determined as 64/76, 63/82 and 62/84 respectively. The moisture content of the samples was determined as 64.25 and 63.37, respectively, due to the addition of 0 and 1% of lactulose powder. Compared to lactulose powder, the addnDUWPIt had a greater effect on changes in the moisture content of cheese samples.

Another part of the findings of this research indicates that parallel to the increase in the ripening time, the moisture content of different samples decreased in the first 30 days and then increased significantly until the end of the storage period (<0.001).*P*). The highest moisture content of a control sample is 66.99 at the beginning of storage and the lowest moisture content is 61.79 for a sample containing 2% powder.DUWP And 1% lactulose was observed on the 30th day. Similar to the trend of increase and decrease in each sample during the storage period in this research, earlier researchers such as Khosrowshahi et al. [35] of theIranian white cheese and Alvarez et al. [36] Synbiotics have been reported in raw cheese. Jovandeh et al. [37] They stated that the significant decrease in the moisture level of different samples of Iranian cheese containing salt during the ripening period is caused by the osmotic pressure caused by the placement of the cheese clot in the brine solution and the diffusion of salt into the cheese matrix and the removal of water from the cheese tissue. In another study, Kerami et al. [5] They stated that there is no cutting step in the process of producing cheese using the ultra-refining method. Therefore, it seems that this observed difference in the amount of moisture content of different samples can be caused by the difference in their water content during the storage period.

One-way analysis of the data also showed the existence of a significant effect between the average humidity of the tested treatments (Figure 1). In this graph, it is clear that with the increase of both lactulose powder andDUWP, the moisture content of cheese decreases significantly.

Islam and colleagues [33] In similar results, they reported changes in moisture content due to the addition of compounds such as Permit powder and lactulose to synbiotic samples. As mentioned earlier, prebiotic compounds increase the population of probiotic bacteria and increase the amount of proteolytic activity. Proteolysis causes the breaking of protein networks and the release of soluble compounds and small molecules from inside the cheese tissue to the outside. For this reason, their removal causes the amount of dry matter to decrease and the amount of moisture to increase. Blue cheese powder with reduced solutes increases the amount of moisture in the tissue of the samples due to its high ability to retain water in the tissue of the samples. Therefore, the addition of ultra-refined whey powder probably improves the three-dimensional casein networks in addition to increasing the water retention capacity [38]..

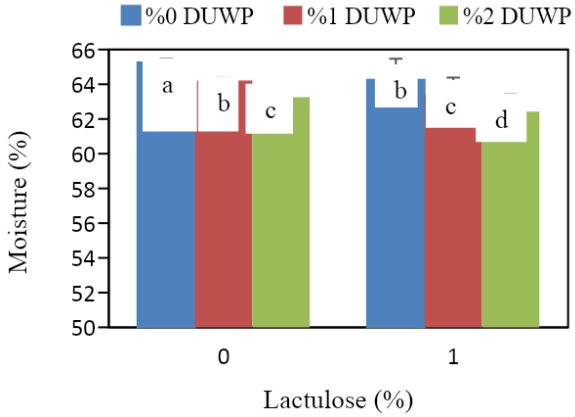

FIG 1. Effect of addition of demineralized ultrafiltrated whey powder (DUWP) and lactulose powder on moisture content of synbiotic ultrafiltrated cheeses.

3-3- Synersis changes

The results of the findings (Table 1) indicated that although the addition of powderDUWP and lactulose increased the amount of cheese syneresis, but these changes did not occur (0.05).<*P*). On average, the amount of syneresis of samples containing 0, 1 and 2 percent of powderDUWP 2.55, 2.69, and 2.86, respectively, and the average syneresis of Farapaludhi cheese samples containing 0 and 1% lactulose powder was also determined as 2.54 and 2.70, respectively.

Tamim and Robinson in us [39] and Jesus and the king [40] In Mozzarella cheese, they reported similar results and attributed the change in syneresis to the increase of ultra-refined cheese powder, because ultra-refined cheese powder increases the integration of casein strands and increases the density of protein matrix networks, therefore syneresis increases in the samples. In any case, perhaps the main reason is the increase in syneresis along with the increase in the amount of lactulose powdersDUWP can be attributed to the increase in cheese acidity; Because the increase in acidity leads to the removal of more water from the cheese curd [1]..

Contrary to the results of the present study, Jovandeh et al. [37] In Mast and Olfa et al. [41] In yogurt containing lactulose, they stated that the addition of prebiotic compounds due to increasing the dry matter of the product increases the amount of water holding capacity during the storage period and therefore reduces the amount of syneresis.

Based on the obtained results, the storage time also had an effect on the amount of syneresis of the samples; So that with the passing of the storage period, the amount of syneresis increased significantly until the middle of the storage period and then decreased until the end of the storage period (<0.001).*P*).

The increase in syneresis of cheese along with the increase in storage time until the middle of the period, as mentioned above, can be due to the increase in the acidity of cheese. The decrease in syneresis or in other words the increase in cheese moisture can also be due to the increase in the hydrophilic properties of cheese protein as a result of the development of proteolysis [1]. Another hypothesis proposed to reduce syneresis in casein gels during storage by Hasan et al. [42] and Qasimpour et al. [43] has been proposed that low storage temperature increases the number and strength of bonds between the components of the gel structure and increases the water retention capacity, and in this way, the passage of time can lead to a decrease in syneresis.

The investigation of mutual effects between the studied variables can be seen in Table 1. As can be seen in this table, there was no interaction between the test variables in terms of syneresis (0.05).*P*>).

4-3- Protein changes

Findings of changes in the amount of protein due to the addition of two powder variablesDUWP and lactulose powder to ultra-refined cheese during storage period in tables۱ And 2 has come. Like Synersis, Add any of the powdersDUWP and lactulose It did not have a significant effect on the protein content of the synbiotic ultra-pasteurized cheese samples, but the storage time made significant changes in this regard (<0.001).*P*). BOn average, the amount of syneresis of samples containing 0, 1 and 2 percent of powderDUWP 12.05, 11.97 and 11.90 were determined, respectively, and the protein content of the samples was determined as 12.03 and 11.92, respectively, due to the addition of 0 and 1% lactulose powder. So addEach of the powdersDUWP And lactulose caused a slight decrease in protein in cheese samples. The reason for the reduction of cheese protein in this

context can be related to the important role of casein in the formation of the protein network; Because the combination of any other material causes a decrease in the concentration of casein and the interference of materials (egDUWP and lactulose) in the formation of casein protein network.According to the findings of Jovandeh and Minhas [38] ،Addition of concentrated fermented whey protein decreased the amount of protein recovery before and after protein formation. In the aforementioned research, the reason for the reduction of protein recovery in Iranian white cheeses due to the increase in the amount of protein in concentrated fermented cheese is attributed to the lack of formation of a suitable three-dimensional casein network. In confirmation of these results, Dybing and Smith [44] stated that the addition of treated solutions of cheese proteins can reduce the amount of protein recovery.

Also the results speak for it hadThatThe amount of protein in cheese samples٣٠ It increased significantly on the first day and then decreased somewhat until the end of the storage period.To justify the obtained results, the results of Kerami et al. [5] and Torabi et al. [10] can be cited. They attributed the reason for the increase and subsequent decrease in the amount of protein during the storage period to changes in the amount of moisture because humidity can affect the process of changes in the amount of protein. Also, due to proteolysis, proteins are converted into peptides and amino acids, and this causes the amount of protein to decrease [5 and 10]. Rodan et al. [45] also related the process of proteolysis with the amount of fat and moisture, the increase of fat and moisture increases the amount of proteolysis, and the decrease of fat and moisture also decreases the amount of proteolysis..

5-3- Changes of nitrogen dissolved in water to total nitrogen

The ratio of water-soluble nitrogen to total nitrogen (WSN/TN) in cheese samples can be considered as an index of proteolysis or cheese ripening [46]. The changes in the proteolysis index of synbiotic ultra-cured cheese samples during a 60-day storage period are shown in Tables 1 and 2. As can be seen, by adding each of the powdersDUWP and lactulose, ratio valueWSN/TN It increased in all samples(0١/٠>*P*). Average amountWSN/TN Cheese samples containing 0, 1 and 2 powdersDUWP 7/40, 7/63 and 7/97 were determined respectively and the amountWSN/TN The samples containing 0 and 1 percent of lactulose were determined as 7.48 and 7.84, respectively. Looking at tables 1 and 2, the changes of this index show that the duration of storage also affects the intensity of proteolysis of different cheese samples and the amount of proteolysis has increased.(0١/٠>*P*). However, according to the findings of Table 1 and Figure 1, no interaction between the tested variables was observed in this regard.(٠5/٠*P*>).

In justifying the changes in proteolysis during a storage period, one can refer to the studies of Jovandeh et al. [47]. cited In addition to chymosin in cheese, they identified the moisture to protein ratio in cheese as the main responsible for proteolysis during cheese storage. According to the statements of the mentioned researchers, the low-fat samples have a lower moisture content per protein unit despite the high moisture content, while the high-fat samples have a higher moisture-to-protein ratio despite the lower moisture content. As a result, the access of the enzyme to the protein substrate increases and causes a significant increase in the proteolysis index throughout the storage period [47].. For the reasons mentioned, higher moisture to protein ratio increases the rate of proteolysis. findings to

The result was also consistent with the results of Zalazar et al. [48]. In this research, the higher rate of proteolysis in samples containing higher moisture content or in fact cheese samples containing higher levels of lactulose andDUWP seen.

In addition, it has been reported to add compounds such as inulin and whey proteins [10].And lactulose [23] It increases the activity of starter and probiotic bacteria, and as a result, the amount of proteolysis caused by them increases. Increasing proteolysis due to the proteolytic activity of starter or probiotic bacteria has been reported by many researchers [31, 50-49].

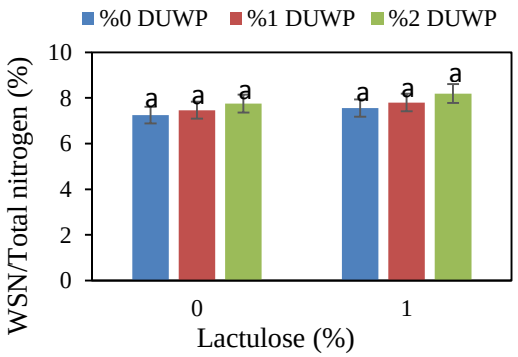

FIG 2. Effect of addition of demineralized ultrafiltrated whey powder (DUWP) and lactulose powder on water soluble nitrogen to total nitrogen ratio (WSN/TN) of synbiotic ultrafiltrated cheeses

3-6- Fat changes

Lipolysis is a process during which fats are broken down by the natural lipase enzyme of milk, lipase produced by the microbial flora (initiating microbes) of cheese and also some types of rennet. The process of lipolysis causes the production of fatty acids and glycerol in cheese, and as a result, the development of aroma and flavor in the product. Among the mentioned factors, the microbial flora of cheese is considered as the main factor of the lipolysis process. Cheeses that use heat in their production, most of the lipase enzyme in milk is destroyed [5].

As can be seen in table 1 and 2, adding powderDUWP And lactulose had a significant effect on the fat content of the samples(05/•>*P*). On average, the fat content of samples containing 0, 1 and 2 percent powderDUWP It was determined as 15/88, 15/74 and 15/59 respectively. The fat content of the samples was determined by adding 0 and 1% of lactulose powder, respectively, 15.83 and 15.65. By looking at Table 2, it can be seen that the effect of adding powderDUWP And lactulose increases by reducing the amount of fat in cheese samples with the passage of storage time, so that at the end of 60 days of storage, the difference in the amount of fat between the treatments reaches its maximum. As mentioned in the case of proteolysis, this condition is probably due to the positive effect of the powderDUWP And lactulose is on the activity of starter and probiotic bacteria, as a result of their activity, it is normal for lipolysis to take place more intensively.

Based on the obtained results, increasing the duration of storage also causes significant changes(0١/•>*P*) in the fat content of the samples. The fat content of the cheese samples increased insignificantly with the passage of storage time until the middle of the period, and then decreased significantly until the end of the storage period (<0.05).*P*). The reason for the increase in fat at the beginning of the storage period is probably due to the removal of moisture from the cheese and the increase of all its dry matter including fat [10]. Jovandeh and Minhas [38] In investigating the effect of adding protein concentrate of fermented cheese on the physicochemical characteristics of feta cheese They showed that the addition of this concentrate to cheese making milk caused a significant increase in moisture and a decrease in fat.

The researchers attributed the increase in fat at the beginning of cheese storage to high acidity and the presence of lactic acid bacteria in the concentrate; Because due to the increase in acidity, the amount of syneresis increases and a cheese with a denser texture is produced. On the other hand, with the increase of storage time and the development of proteolysis and lipolysis in cheese, increasing the moisture content of cheese on the one hand and breaking down fat on the other hand will reduce the fat in cheese [38]. The decrease in fat at the end of the storage period is probably due to the development of lipolysis of cheese, especially by lactic acid bacteria, and the slight increase in cheese moisture by other researchers in products such as synbiotic yogurt [34] and Synbiotic ultra-pasteurized cheese has been reported [51].. del Silveira et al. [52] also attributed fat changes to the effect of moisture content; In other words, reducing the amount of moisture in the product causes an increase in the amount of fat in it. Meanwhile, Torabi et al. [53], in addition to humidity changes, factors such as storage temperature, salt concentration, and dehydration properties of proteins under the influence of humidity were found to be effective in reducing and increasing the amount of fat.

The results of data analysis showed the absence of interaction between the three tested variables on the process of fat changes (<0.05).*P*).

4 - Conclusion

Today, with the expansion of consumers' awareness, synbiotic foods are highly regarded as super-beneficial or practical foods. One of the main concerns of the food industry is the preservation of probiotic bacteria in practical foods. One of the most important methods used to preserve these bacteria is the use of prebiotic compounds. The aim of the leading research is to investigate the possibility of producing synbiotic cheese containing prebiotic compounds of permeate powder or ultra-refined cheese with reduced salts.DUWP) and lactulose powder with acceptable physicochemical characteristics. The results showed that the addition of Permit powder and lactulose caused a significant decrease and increasepH And the acidity was maintained over time. These compounds also reduced the amount of moisture in the tissue and increased the amount of syneresis. The addition of Permit powder and lactulose during the ripening period caused the development of proteolysis and lipolysis in cheese, which could lead to the improvement of the quality of the produced samples. Among the production samples, the cheese sample contains one percent of each of the powdersDUWP and lactulose had a more cohesive texture quality (due to lower moisture and higher acidity) and more favorable sensory properties (due to higher proteolysis index or ripening rate) (results not shown). According to the health promoting properties of the synbiotic cheese sample containingDUWP and lactulose, the production and consumption of this beneficial product is suggested with the aim of improving the health of society on an industrial scale.

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6- References

[1] Jooyandeh, H. 2022.*Application of enzymes in dairy products*. 1st ed., Khuzestan Agricultural Sciences and Natural Resources University Press. (In Persian)

[2] Ghoddusi, H.B., Habibi Najafi, M.B., Mazaheri Tehrani, M., and Razavi, M.A. 2004.*Feta and related cheeses*. 2nd ed., Mashhad University Press. (Translation), 157-155. (In Persian)

[3] Vigne, J.D. 2011. The origins of animal domestication and husbandry: A major change in the history of humanity and the biosphere. *Biology Reports*. 334(3), 171–181.

[4] Mistry, V.V. and Maubois, J.L. 2017. Application of Membrane Separation Technology to Cheese Production. *Cheese: Chemistry, Physics and Microbiology*. 27, 677-697.

[5] Karami, M., Ehsani, M.R., Mousavi, M. A., Rezaei, K. A. and Safari, M. 2009. The effect of ripening time on fatty acid profile, microstructure and sensory properties of UF feta cheese. *Iranian Journal of Biosystem Engineering.* 40(1), 101-110. (In Persian)

[6] Doyon, M. and Labrecque, J.A. 2008. Functional foods: A conceptual definition. *British Food Journal.* 110(11), 1133-1149.

[7] Tayibi Moghadam, S. and Ehsani, M.R. 2019. Comparison of the effect of inulin extracted from native chicory root with commercial inulin on the viability of probiotics and the physicochemical, rheological and sensory properties of synbiotic mast. *Food Science and Industry.* 17(99), 1-16.

[8] Rodrigues, D., Rocha-Santos, T.A.P., Pereira, C.I., Gomes, A.N., Malcata, F.Z. and Freitas, A.C. 2011. The potential effect of FOS and inulin upon probiotic bacterium performance in curdled milk matrices. *Journal Food Science and Technology*. 44, 100-108.

[9] Rostamabadi, H., Jooyandeh, H. and Hojjati M. 2016. Optimization of Iranian low-fat cheese with addition of Persian and almond gums as fat replacers by Response Surface Methodology. *Research and Innovation in Food Science and Technology*, 5(3), 235-248. (In Persian)

[10] Torabi, F., Jooyandeh, H. and Noshad, M. 2021. Evaluation of physicochemical, rheological, microstructural, and microbial characteristics of synbiotic ultrafiltrated white cheese treated with transglutaminase. *Journal of Food Processing and Preservation.* 45(4), 1-11.

[11] Bulut Solak, B. and Akin, N. 2012. Health Benefits of Whey Protein: A Review. *Journal of Food Science and Engineering.* 2, 129-137.

[12] Jooyandeh, H., Minhas, K.S., and Kaur, A. 2009. Sensory quality and chemical composition of wheat breads supplemented with fermented whey protein concentrate and whey permeate. *Journal Food Science and Technology.* 46(2), 146-148.

[13] Alimoradi, F., Hojati, E., Jooyandeh, H., Zehni-Moghadam, S.A.H. and Moludi, J. 2016. Whey proteins: Health benefits and food applications. *Journal of International Research in Medical and Pharmaceutical Sciences*. 9(2), 63-73.

[14] Beidaghi, M., and Movassagh, M. H. 2019. The effect of adding ewe's cheese whey on the quality of kefir drink. *Journal of Food Science and Technology*. 16(93), 135-142. (In Persian)

[15] Danesh, E., Goudarzi, M., and Jooyandeh, H. 2017. Effect of whey protein addition and transglutaminase treatment on the physical and sensory properties of reduced-fat ice cream. *Journal of Dairy Science*. 100, 5206–5211.

[16] Jooyandeh, H. 2020. Evaluation of physical and sensory properties of Iranian Lavash flat bread supplemented with precipitated whey protein (PWP). *African Journal of Agriculture and Food Security*. 8(2), 1-7.

[17] Jooyandeh, H. 2009. Effect of fermented whey protein concentrate on texture of Iranain white cheese. *Journal of Texture Studies*. 40(5), 497-510.

[18] Kouravand , F. , Jooyandeh , H. , Barzegar , H. and Hojjati , M. 2018-linked whey protein isolate-based films containing *Satureja khuzistanica* Jamzad essential oil. *Journal of Food Processing and Preservation*. 42(3), e13557, 1-10.

[19] Balthazar, C.F., Silva, H.L.A., Cavalcanti, R.N., Esmerino, E.A., Cappato, L.P., Abud, Y.K.D., et al. 2017. Prebiotics addition in sheep milk ice cream: A rheological, microstructural and sensory study. *Journal of Functional Foods*. 35, 564-573.

[20] Nicholson, J. K., Holmes, E., Kinross, J., Burcelin, R., Gibson, G., Jia, W., and Petterson, S. 2012. Host-gut microbiota metabolic interactions. *Science.* 336, 1262-1267.

[21] Nooshkam, M., Babazadeh A., and Jooyandeh, H. 2018. Lactulose: Properties, techno-functional food applications, and food grade delivery

system. *Trends in Food Science and Technology*. 80, 23-34.

[22] Jirsarai, B., Fadai, V. and Noghani, R. 2015. The effect of inulin and lactulose on the survival of Lactobacillus casei and the physicochemical and sensory characteristics of probiotic ultra-refined feta cheese. *Food Science and Nutrition.* 14(1), 46-35.

[23] Momenzadeh, S., Jooyandh, H., Alizadeh Behbahani, B., and Barzegar, H. 2021. Evaluation of physicochemical and sensory properties of half-fat synbiotic stirred yogurt containing Panirak (*Ignored mallow*) and lactulose. *Journal of Food Science and Technology.* 18(120), 353-363. (In Persian)

[24] Jooyandeh, H., Danesh, E., and Goudarzi, M. 2017. Influence of Transglutaminase Treatment on Proteolysis and Lipolysis of Low-Fat White-Brined Cheese Incorporated with Whey Proteins during Ripening. *Journal of Food Technology and Nutrition.* 15(4), 31–44. (In Persian)

[25] AOAC. 2005. Official Methods of Analysis. 18th ed, Association of Official Analytical Chemists, Gaithersburg, Maryland, USA.

[26] Egan, H., Kirk, R. S. and Sawyer, R. 1981. Pearson's Chemical Analysis of Foods. eighth edition, *Journal of Association of Official Analytical Chemists*, 7(5), 497-499.

[27] Kuchroo, C. N. and Fox, P. F. 1982. Soluble nitrogen in cheddar cheese: comparison of extraction procedures. *Dairy science*. 37, 331-335.

[28] Oliveira, R.P.D.S., Florence, A.C.R., Perego, P., De Oliveira, M.N. and Converti, A. 2011. Use of lactulose as prebiotic and its influence on the growth, acidification profile and viable counts of different probiotics in fermented skim milk. *International Journal of Food Microbiology.* 145(1), 22-27.

[29] Buriti, F.V.C.A., Cardarelli, H.S.R., Filisetti, T. M.C.C. and Saad, S.M.I. 2007. Synbiotic potential of fresh cream cheese supplemented with inulin and Lactobacillus paracasei in co-culture with Streptococcus thermophiles. *Food Chemistry*. 104, 1605–1610.

[30] Cardarellia, H.S.R., Buritia, F.C.A., Castrob, I.A. and Saad, S.M.L. 2008. Inulin and oligofructose improve sensory quality and increase the probiotic viable count in potentially synbiotic petit-suisse cheese. *LWT- Food Science and Technology*. 41(6), 1037-1046.

[31] Abd-Rabou, H.S., ElZiney, M.G. Awad, S.M., Sobhy A El Sohaimy, S.A. and Dabour, N.A. 2016. Impact of Probiotic and Synbiotic Supplementation on the Physicochemical, Texture and Sensory Characteristics of Wheyless Domiati-Like Cheese. *MOJ Food Processing and Technology.* 3(3), 1-10.

[32] Aghajani, A.R., Pourahmad, R. and Mahdavi Adeli, H. 2011. The Effect of Prebiotics on Probiotic Yogurt Containing Lactobacillus casei. *Food Technology and Nutrition.* 8(4), 73-83.

[33] Islam, M., Alharbi, M.A., Alharbi, N.K., Rafiq, S., Shahbaz, M., Murtaza, S., Raza, N., Farooq, U., Ali, M., Imran, M. and et al. 2022. Effect of Inulin on Organic Acids and Microstructure of Synbiotic Cheddar-Type Cheese Made from Buffalo Milk. *Molecules.* 27, 1-12.

[34] Sarwar, A., Aziz, T., Al-Dalali, S., Zhao, X., Zhang, J., ud Din, J., Chen, Ch., Cao, Y., and Yang, Zh. 2013. Physicochemical and Microbiological Properties of Synbiotic Yogurt Made with Probiotic Yeast Saccharomyces boulardii in Combination with Inulin. *Foods*. 8(10), 468-488.

[35] Khosrowshahi. A., Madadlou, A., Ebrahim Zadeh Mousavi, M., and EmamDjomeh, Z. 2006. Monitoring the Chemical and Textural Cheese During Ripening of Iranian White Cheese Made with Different Concentration of Starter. *Journal Dairy Science.* 89(9), 3318-3325.

[36] Alves, L.L., Richards, N.S.P.S., Mattanna, P., Andrade, D.F., Rezer, A.P.S., Milani, L.I.G., Cruz, A.G. and Faria, J.A.F. 2012. Cream cheese as a symbiotic food carrier using *Bifidobacterium animal* Bb-12 and *Lactobacillus acidophilus* La-5 and inulin. *International Journal of Dairy Technology.* 65(1), 63-69.

[37] Jooyandeh, H., Mortazavi, S.A., Farhang, P. and Samavati, V. 2015. Physicochemical properties of set -style yoghurt as effect by microbial transglutaminase and milk solids contents. *Journal of Applied Environmental and Biological Sciences.* 4(11S), 59 -67.

[38] Jooyandeh, H. and Minhas, K.S. 2009. Effect of addition of fermented whey protein concentrate on cheese yield and fat and protein recoveries of Feta cheese. *Journal of Food Science and Technology.* 46(3), 221-224.

[39] Tamime, A.Y. and Robinson, R.K. 2007. *Tamime and Robinson's Yoghurt: Science and Technology*. A volume in Woodhead Publishing Series in Food Science, Technology and Nutrition. 1-20.

[40] Zisu, B., and Shah, N.P. 2005. Textural and functional changes in low-fat Mozzarella cheeses in relation to proteolysis and microstructure as influenced by the use of fat replacers, pre-acidification and EPS starter. *International Dairy Journal.* 15(6), 957-972.

[41] Olfa, B.M., Marwa, M., Moncef, C., Mouna, B. and Mnasser, H. 2019. The combined effect of phytosterols and lactulose supplementation on yoghurt quality. *Journal of Food and Nutrition Research.* 7(4), 261-269.

[42] Hassan, L.K., Haggag, H.F., ElKalyoubi, M.H., Abd EL -Aziz, M., El -Sayed, M.M. and Sayed, A.F. 2015. Physico -chemical properties of yoghurt containing cress seed mucilage or guar gum. *Annals of Agricultural Sciences*. 60(1), 21 - 28.

[43] Ghasempour, Z., Alizadeh, M. and Bari, M.R. 2012. Optimisation of probiotic yoghurt production containing Zedo gum. *International Journal of Dairy Technology.* 65(1), 118 -125.

[44] Dybing, S.T. and Smith, D.E. 1998. The Ability of Phosphates or κ-Carrageenan to Coagulate Whey Proteins and the Possible Uses of Such Coagula in Cheese Manufacture1. *Journal of Dairy Science.* 81(2), 309-317.

[45] Rudan, M.A., Barbano, D.M., Joseph yun, J. and Kindstedt, P.S. 1999. Effect of Fat Reduction on Chemical Composition, Proteolysis, Functionality, and Yield of Mozzarella Cheese. *Journal Dairy Science*. 82, 661-672.

[46] Danesh, E., Goudarzi, M., and Jooyandeh, H. 2018. Transglutaminase-mediated incorporation of whey protein as fat replacer into the formulation of reduced-fat Iranian white cheese: physicochemical, rheological and microstructural characterization. *Journal of Food Measurement and Characterization*. 12(4), 2416-2425.

[47] Jooyandeh, H., Rostamabadi, H., and Hojjati, M. 2017. Effect of Persian and almond gums as fat replacers on the physicochemical, rheological, and microstructural attributes of low-fat Iranian White cheese. *Food Science and Nutrition.* 14(3), 669-677.

[48] Zalazar, C.A., Zalazar, C.S., Bernal, S., Bertola, N., Bevilacqua, A., and Zaritzky, N. 2002. Effect of moisture level and fat replacer on physicochemical, rheological and sensory properties of low fat soft cheeses. *International Dairy Journal*. 12(1), 45-50.

[49] Barbosa , I.C. , Oliveira , M.E.G. , Madruga , M.S. , Gullon , B. , Pacheco , M.T.B. , Ana M.P. et al. 2016. Influence of the addition of*Lactobacillus acidophilus* La-05,*Bifidobacterium animalis* subsp. *of milk* Bb-12 and inulin on the technological, physicochemical, microbiological and sensory features of creamy goat cheese. *Food Function.* 7(10), 4356-4371.

[50] Cruz, A. G.; Buriti, C.; Souza, C. B. H.; Faria, J. A. F. and Saad, S. M. I. 2009. Probiotic cheese: health benefits, technological and stability aspects. *Trends in Food Science and Technology*. 20(8), 344–354.

[51] El, B. and Azza, M. 2013. The use of inulin as a dietary fiber in the production of symbiotic Uf-Soft cheese. *Journal of Food and Dairy Science.* 4 (12), 663 – 677.

[52] Da Silveira, E.O., Jose H. Lopes Neto, J.H., da Silva, L.A., Raposo, A.E.S. Marciane Magnani, M. and Cardarelli, H.R. 2015. The effects of inulin combined with oligofructose and goat cheese whey on the physicochemical properties and sensory acceptance of a probiotic chocolate goat dairy beverage. *LWT - Food Science and Technology.* 62(1), 445-451.

[53] Torabi, F., Jooyandeh, H., Noshad, M. and Barzegar, H. 2019. Modeling and Optimization of Physicochemical and Organoleptical Properties and *Lactobacillus acidophilus* Viability in Ultrafiltrated Synbiotic Cheese, Containing Microbial Transglutaminase Enzyme, Whey and Inulin. *Research and Innovation in Food Science and Technology*. 8(2), 137-150. (In Persian)

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مقاله علمی_پژوهشی

بررسی ویژگی‌های فیزیکوشیمیایی پنیر فراپالوده‌ی سین‌بیوتیک حاوی پودر آب‌پنیر فراپالایش املاح‌گیری شده و لاکتولوز طی مدت نگهداری

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چکیده

پنیر سفید فراپالایش، نسل نسبتاً جدیدی از پنیرهای سفید است که با کمک فرایند اولترافیلتراسیون تولید می‌شود. این پنیر دارای بافتی نرم و مالش‌پذیر بوده و پس از گذشت مدت کوتاه رسیدگی وارد بازار می‌شود. لاکتولوز، یک ماده پری‌بیوتیک است که علاوه بر تأثیر مثبت بر رشد باکتری‌های پروبیوتیک، اثر سلامتی‌بخشی آن بر سلامت انسان تأیید شده است. در این تحقیق، برای تولید پنیر سین‌بیوتیک، از پودر آب‌پنیر فراپالایش (پرمیت) با املاح کاهش یافته (DUWP) در سه سطح ۰، ۱ و ۲ درصد، لاکتولوز در دو سطح ۰ و ۱ درصد و از باکتری *بیفیدوباکتریوم بیفیدوم* به عنوان باکتری پروبیوتیک استفاده گردید. نمونه‌های تولیدشده از نظر خواص فیزیکوشیمیایی شامل pH، اسیدیته، رطوبت، سینرسیس، چربی، پروتئین، و نسبت نیتروژن محلول در آب به نیتروژن کل در مدت ۶۰ روز در دمای ۴ درجهٔ سانتی‌گراد ارزیابی شدند. یافته‌ها حاکی از آن بود که افزودن DUWP و لاکتولوز به‌غیر از پروتئین بر سایر ویژگی‌های مورد بررسی معنی‌دار بود. مدت زمان نگهداری نیز بر تمامی ویژگی‌های فیزیکوشیمیایی مورد بررسی اثر معنی‌داری داشت ($P<۰/۰۱$). براساس نتایج این تحقیق مشخص گردید که بهترین نمونه با استفاده از غلظت ۱ درصد از هر یک از پودرهای لاکتولوز و DUWP به‌دست می‌آید.