**Color, Sensory, and Microbiological Properties of Jordanian White Brined Cheese Prepared From Different Types of Milk with/or Without Yogurt Starter Culture**

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**Abstract**

: Boiled and fresh White brined cheese (WBC) . produced in Jordan usually made from sheep milk by family of animal proprietors or in small dairy production plants directed to produce WBC that boiled (90–100 °C) then stored under brine until use . This study was aimed to evaluate the use of different milk types (ewes, goats,), storage time and starter culture additions on color measured by Hunter lab., microbiological and sensory properties.

:The WBC which known as Nabulsi cheese prepared from different combination ewe's, goat's and by dairy processing plant at Mutah University/Faculty of Agriculture and tested for microbiological content, color ( Hunter Lab.) and sensory properties (Panels).

 the results showed The WBC produced from different milk mixtures contains on 5.72±0.23 - 3.08±053, and 2.35±3.32 - 1.56±2.05 log CFU/g of both mesophilic (APC) and Coliform bacteria, respectively. The color test showed that cheese produced from mixing 25% sheep’s milk and 75% goat’s milk had the highest effect of L\* = 95.53, a\*= 63.30, and b\* 11.16 ( Lightness, whiteness, and chromaticity coordinate).The whiteness index showed improvement with increasing storage time at 6 monthsof63.07± 1.78compared to initial color reading.The appearance of WBC was not significantly affected in relevance to mixing percentages of 25% sheep’s and 75% goat’s milks that had the highest preference score of 8.38. The decrease in whiteness index of cheese produced by the addition of starter culture compared to control treatment .The WBC color, appearance and taste were similar regardless of starter culture addition.Key words: WBC , Sensory evaluation ,CIE lab system (L\* a\* b\*).

**Introduction**

White Brined cheese (WBC) originated in East-Mediterranean counters about 8000–9000 years ago. More than 1000 varieties of cheese are produced around the world. cheese represents one of the most popular food products in the world. This is probably thanks to its richness in nutritional components like proteins, short-chain FAs, vitamins (e.g., riboflavin, thiamin, vitamin B12), and minerals such as calcium, phosphorus (Umayma Boukria,2020).White brined cheeses are of cheeses popular traditionally in Jordan and called Nabulsi cheese, mainly manufactured from sheep or goat milk or rarely from cow's milk. The WBC produced from unpasteurized mixtures of these milk types by adding rennin enzyme to milk tempered to approximately 35°C. or. with or without addition starter culture to milk that can give satisfactory results with respect to acidification of the milk . (Al-Nabulsi, 2011, Abu-Alruz et al., 2009b).

Mixing milk from different species can be a way of improving the quality of fermented dairy products and developing new ones with specific nutritional (biochemical), physicochemical, sensory, and rheological properties. Regarding this opportunity, it is of the utmost importance to characterize the quality features of products derived from mixing different milk species to obtain products with proper characteristics and satisfactory acceptance by consumers. (Umayma Boukria,2020).It’s a semi-hard cheese and, can be used as stuffing in the production of Kunafa and Pastries or eaten fresh After remove the salt, a by the soaking in water (Yamani et al., 1998).

Used goat, sheep or cow milk, or a mixture of milks, to made White-brined cheese its a suitable environment for the growth of microbes to contain the necessary elements for growth ,Thus must be ,preventing microbial contamination source that occur throughout the manufacture and storage of the cheese (Oumayma ,et al ,2020). by good hygiene practices to reduce a possible exposure of food-borne pathogens and chemical milk residues. because the safety and shelf-life of the final product dependent on the micro flora present (Park, 2006). Several studies had been conducted to improve the quality and safety of local Nabulsi cheese, filing cheese into glass jars with brine solution and hot filing (Humeid and Tukan 1986,1990). Herzallah (1994) studied the effect of different combinations of pH and salt concentration of the brine on the storage ability and sensory

quality of. Boiling Nabulsi cheese made from ewe’s milk by the traditional method and stored in brines of different acid/salt combinations. examined chemically, microbiologically and organoleptically, who found that the best pH/salt combination recommended as storage medium for Nabulsi cheese was 10%salt and pH 4.0. This combination resulted in reduction of the number of total viable microorganisms, extended shelf life and better texture combined with moderate moisture content of the cheese.

Therefore, the study aimed manufacturing white brine cheese from different proportions of goat and sheep milks to improve the color ,microbial and, sensory properties of cheese stored at room temperature for 6,12 months.

**Materials and Methods**

**Starter cultures**

Streptococcus thermophilus (ST-B01) and LLactobacillus bulgaricus USED as traditional starter culture 1, 1 at the level of 2% (w/v)were obtained from Chr. Hansen Holding A/S (Horsholm, Denmark

**Milk sample**

Fresh sheep and goat’s milk used to produce Nabulsi cheese were obtained from the farm of the Faculty of Agriculture, Mutah University. The milk filtered, quality tests includes for specific gravity using lactometer (Brannan, UK); pH was measured using calibrated pH meter (Hanna, ); % acidity as lactic acid was determined by titration with a standardized solution of sodium hydroxide; and moisture was determined using oven drying method, the protein was determined using Kjeldahl method, fat was determined using Gerber method .Testing methods performed according to Association of Official Analytical Chemistry (AOAC,2020) methods.

**Cheese making:** Nabulsi cheese prepared according to the Jordanian standards in the dairy factory of the Faculty of Agriculture, Mutah University using five different combinations from sheep and goat milk. The combinations were designated as CMR1: 100% goat’s milk, CMR2: 100%sheep’s milk, CMR3: 25% goat’s milk and 75% sheep’s milk, CMR4: 50% goat’s milk and 50% sheep’s milk, and CMR5: 75% goat’s milk and 25% sheep’s milk. The production technique developed by Humeid and Tukan(1986), Briefly, boiling shaped cheese pieces in 18% salt solution then boilingtheclosed lid glass containers for ( min).

**Microbiological quality analyses**

Total viable count was enumerated according to an ISO/IDF method (ISO/IDF, 2002). Briefly, 11-g of cheese was blended with 99 mL of sterilized phosphate Buffered Peptone Water (0.1% peptone).Serial dilutions were used for the determination of total aerobic plate count (APC) using plate count agar medium ( and incubated at 35±°C for 48 ±hours, coli form count (CC) using violet red bile (VRB) after incubated at 35±°C for 24± and .Halophilic bacteria was checked using phosphate buffer(3% NaCl).Extreme halophilic bacteria (using halophilic agar) and Moderate halophilic bacteria using tryptose soy agar with salt concentration equivalent to that of cheese. Mesophilic yeast and mold **(**using Dichloran with 18% glycerol agar (DG 18 agar) after incubating at 25°C for 5 days(ISO 14461-2|IDF 169-2:2005

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**Color measurements**

The cheese samples were **tested** for color variation after desalting; through soaking for overnight at refrigeration at 50C, the measured by the CIE lab system. The CIE values (L\* a\* b\*) was used to evaluate cheese color (On Color, cyberchrome, USA)where L\* represents lightness (ranges from 0 “black” to 100 “white”), the a\* denotes red/green, and the b\* denotes the yellow/blue as described by Leon, K. (2006)

**Sensory evaluation**

Twenty professional panelists were participated in evaluation of WBC sensory characteristics. The sensory evaluation parameters were color, odor, sourness, smoothness, sweetness ,viscosity, after taste and overall acceptability using Nine-point hedonic scale ranging from 1 (“dislike extremely”) to 9 (“like extremely”) after 14 days of storage time. The WBC samples presented to panelists at15± °C.

**Statistical Analysis**

The produced data were reduced using SPSS (Ver.22) to evaluate the effect of various milk species on WBC quality parameters tested at (P< 0.05).

**Results and Discussion**

**Milk composition**

The chemical compositions of Sheep and Goat's milk are shown in Table 1.

**Table 1:** Sheep's and Goat's milk composition1

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Milk** | **Protein** | **Fat** | **Dry matter** | **Ash** | **pH** | **Acidity** | **Moisture** | **Specific gravity** |
| **%** |
| **Sheep’s milk** | 6.79 ± 0.18 | 5.45 ± 0.35 | 16.87 ± 0.19 | 0.71 ± 0.05 | 6.61 ± 0.01 | 0.18 ± 0.01 |

|  |  |
| --- | --- |
| 83.19 ± 0.19 |  |

 | 1.04 ± 0.01 |
| **Goats milk** | 4.04 ± 0.03 | 3.5 ± 0.28 | 11.96 ± 0.15 | 0.52 ± 0.09 | 6.69 ± 0.14 | 0.14 ± 0.01 | 88.05 ± 0.15 | 1.03± 0.01 |

1values are means ± standard deviation.

The results of milk composition analysis are presented in Table1and it showes that sheep’s milk is suitable for cheese production because had higher values of protein, fat, ash, dry matter and calcium and casein ( Barłowska,etal 2011). Also effect of milk composition, physicochemical, sensory, rheological, and microbiological properties on the quality of dairy product (Oumayma et al ,2020) and microbiological load of milk can vary based on animal health, milking sanitary condition, milking environment and the milk handler health (Biruk et al., 2009)

The chemical composition of fresh milk is affected. of by lactation ,season, animal age and nutrition, genetic factors (species and breed), and udder diseases (Tamime et al. 2011).and milking system and feeding Which affects on the quality of the products (Chilliard et al., 2014).

**Microbial quality**

The results of microbial quality of the white brined cheese produced from different types of milk are shown in ( Table 2), before boiling treatments found to have a high number of aerobic plate count and Coliform were 5.72(±0.23)- 3.08(±053) , 2.35(±3.32) - 1.56(±2.05) log CFU/g, respectively. The aerobic plate count and Coliform count results were insignificantly ( p>0.05)influenced between cheese produced from different milk types.

 This high microbial content and coliform of the cheese samples could be attributed to milk microbial load used in cheese production. Technological parameters, level and types of microbial contamination that occur throughout the manufacture reflects the poor general hygiene conditions used throughout the process of cheese preparation. The control of these factors is an important issue for microbial cheese quality were less than those found by Haddad and Yamani (2017) who found that the standard plate count (SPC), Enterobacteriaceae count (EntC) and yeast and mold count (Y&MC) were 8.3, 5.4 and 3.0, respectively. Also, The results of the current study showed that the Microbial number after in-container heating (zero-time storage), it was very low compared to values before heat treatment. The results of the current study showed that the count of moderate halophilic bacteria was higher at the treatment 1 of 5.37(±0.10) that is significantly different (p>0.05) from other treatments, on the contrary, treatment number 2 found to contain less number of 2.28±0.06 log CFU/g and with no detection of extreme halophilic bacteria and mesophilic Yeast and Mold were not detected. The results showed the presence of moderate halophilic bacteria , aerobic plate count and Coliform after heat treatment to 850C after production (zero-time)) of the Nabulsi cheese filled in glass jars and not detected at treatment 1 and 2. The microbes numbers decreased dramatically with comparison of pre-heat treatment, while treatment after storage for 6 and 12 months at brine solution (18%) and storage at room temperature the microbes were not detected, and could be attributed to the concentration of brine solution of 18% used in keeping the white brined cheese and the efficient of the heat treatment that considered the key step in milk processing and it was enough to destroy most of the microbial cells in the cheese during boiling. WBC considered as a suitable for the growth of only salt tolerant microorganisms (Halophilic)which usually stored in brine solutions of high salt concentration for several months without refrigeration, spoilage of the boiled white cheese showed a pink to red discoloration accompanied and unwanted changes in flavor(Yamani, and Saleh 2019).

**Table 2:** Microbial counts (log CFU/g) of cheese produced from mixing sheep’s and goat’s milk in different ratios before in-container heating and after different storage periods (0, 6, and 12 months)

|  |  |
| --- | --- |
| **Treatments** | **Time of testing1, 2** |
| **Before in-container heating** | **After in-container heating (zero-time storage)** | **After 6 and 12 months of storage** |
| **Types of milk used in processing** | **Aerobic plate count** | **Coliform** | **Moderate halophiles** | **Extreme halophiles** | **Mesophilic yeast and mold** | **Aerobic plate count** | **Coliform** | **Moderate halophiles** | **Extreme halophiles** | **Mesophilic yeast and mold** | **Aerobic plate count** | **Coliform** | **Moderate halophiles** | **Extreme halophiles** | **Mesophilic yeast and mold** |
| **Treatment number** | **Sheep's milk (%)** | **Goat's milk (%)** |
| 1 | 100 | 0.00 | 5.72±0.23a | 2.35±3.32a | 5.37±0.10a | ND3 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2 | 0.00 | 100 | 3.08±053a | 1.56±2.05a | 2.28±0.06c | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 3 | 50 | 50 | 3.91±0.06a | 1.72±1.90a | 2.95±0.95bc | ND | ND | 0.65±0.92a | ND | 0.85±1.20a | ND | ND | ND | ND | ND | ND | ND |
| 4 | 25 | 75 | 4.25±0.75a | 1.65±2.33a | 3.91±0.56b | ND | ND | 1.00±1.4a | ND | 0.80±1.13a | ND | ND | ND | ND | ND | ND | ND |
| 5 | 75 | 25 | 3.96±0.70a | 1.71±2.40a | 3.66±0.643bc | ND | ND | 1.24±1.75a | ND | 0.74±1.05a | ND | ND | ND | ND | ND | ND | ND |

1 Data are presented as Mean±standard deviation.

2 Means in the same column followed by the same letter were not significantly different (P>0.5).

3ND: not detected.

**Color measurement**

The color is an important properties of WBC that has an influence on consumer choice to any food ( Conti-Silvaet et al, 2019), because WBC color considered as an indicators of the product quality ( Spence et al, 2018). Thus changes in cheese color particularly during storage time used to identify variations between different dairy products ( Ryan, et al 2020).

The effect of using sheep’s and goat’s milk in different ratios on the color of the Nabulsi cheese are shown in Table 3**.** It can be seen that there are no significant differences between CMR1of cheese made from sheep’s milk (100%) and CMR2 of cheeses made from goat’s milk (100%) except in the redness, a\* value. for treatment 1 (– 1.38 +0.64) and for CM2( -1.85 +0.69 it is the lowest compared to other treatments, also (a\*) value was negative for all cheese samples processed using different proportions of goat and sheep milk, highest negative a\* values due to its chromaticity portion of green color, caused by the presence of the blue–green pigment (biliverdin) that is absent in cow’s, sheep’s, goat milk ( Abd El-Salam,2011).

It is clear that (Table3) the cheese made from goat’s milk was the brightest (L\* =, 94.20) and cheese produced by mixing 25% sheep’s milk and 75% goat’s milk) which had the highest positive significant effect when compared to other treatments(CM) . It was brightest (coordinates L\* = 95.53 while whiteness was 63.30 ofCM4. The color of goat’s milk being brighter (higher L\* coordinates) than sheep’s, cow milk; because of its ability to convert carotene to vitamin A ( Lucas, etal, 2008)and this means that mixing sheep with goat's milk in certain proportions increases bright (L\*,) , as for cheese produced by mixing 75% sheep’s milk and 25% goats milk treatment 5 and cheese produced by sheep’s milk 100% treatment 1had low whiteness 56.13+4.73 , 57.50+4.66, also the treatment 5 had high yellow (b\* = 13.24+1.75) and low yellow had CM 4 (b\* = 11.16+1.02), respectively. The yellowness (b\* coordinate) and redness (a\* coordinate)” affected in natural pigment amount, such as, lutein and zeaxanthin present in green herbage causing yellowish color the sheep’s and goat’s milks, which are free of β-carotene.The pigment responsible for the yellow color (Prache, et al,2005;Nozière,.et al, 2006).

Table 3: Effect of using sheep’s and goat’s milk in different ratios on color1 and whiteness index2 of the Nabulsi cheese samples3, 4

|  |  |  |
| --- | --- | --- |
| Treatments  | Color coordinates | Whiteness index |
| Treatment CM | Types of milk used in processing | L\* | a\* | b\* |
| Sheep’s milk (%) | Goat’s milk (%) |
| 1 | 100 | - | 94.10±1.80b | -1.38±0.64a | 12.81±1.38ab | 57.50±4.66bc |
| 2 | - | 100 | 94.20±1.08b | -1.85±0.69b | 12.39±1.36b | 58.60±4.15b |
| 3 | 50 | 50 | 94.24±0.91b | -1.36±0.55a | 12.36±1.68b | 58.76±4.33b |
| 4 | 25 | 75 | 95.53±0.83a | -1.44±0.52a | 11.16±1.02c | 63.30±2.61a |
| 5 | 75 | 25 | 93.81±0.66b | -1.45±0.73a | 13.24±1.75a | 56.13±4.73c |

1 L\*, a\*,and b\* according to the CIE lab system.

2Hunter whiteness index.

3means±standard deviation.

4 Means in each column followed by the same letter are not significantly different (P > 0.05).

The redness parameter tended to become greener and yellowness became less with the seasonal time of grazing possibly due to the presence of dried plants in the range and other influencing factors on the concentration of xanthophylls in range species, such as exposure to sunlight (Nozière, et al, 2006). Milk color is affected by many variables such as genetic and nongenetic factors, diet (Langman, et al,2009) and breed (Berry, et al, 2009), and seasonal calving and the manufacturing environment conditions (Walker, et al, 2009) such as (L\* value) after homogenization was high due to reduction of fat globules to smaller sizes and the further association with casein micelles (Bermúdez-Aguirre, et al,2008). It is obvious that as the percentage of goat’s milk exceeded that of sheep’s milk, the color of the Nabulsi cheese improved and became whiter. It appeared that the results of reported color research are often impossible to correctly replicate or interpret (Bojana Milovanovic et el, 2020).

 The results of effect the storage period on color and whiteness index of Nabulsi cheese are summarized in Table4 were the Nabulsi cheese whiteness index appeared to improve with increasing storage time, with maximum significant improvement detected after 6 months (63.07± 1.78). A comparison with zero time, the decrease in cheese whiteness during storage was associated with proteolysis that transform casein into a more soluble state and can cause a decrease in whiteness index after 12 months of 58.56+2.02 compared to zero time storage of 54.94±3.74 which in consistence with results found by Chudy, et al.(2020). The L\* (lightness) values increased significantly ( p<0.05) at six months of storage, on the contrary insignificant changes found at 12 month storage. The redness a\* (red to green) values increased significantly throughout the storage. From -2.27+0.23 to -0.86+0.16 After 12 months. Yellowness (b\* coordinate) values decreased significantly after 6 months of storage of 13.63(±1.26 ) to 10.87(±0.48) ,then, it increased significantly after 12 months of storage.

The change in the a\* and b\* color parameters is mainly due to the increase of the concentration of the cheese components owing to the dehydration throughout the storage process ( Ávila, et al, 2008)

Table 4: Effect of storage time (regardless of the type of milk used) on color1 and whiteness index2 of Nabulsi cheese3, 4

|  |  |  |
| --- | --- | --- |
| Treatments  | Color coordinates  | Whiteness index |
| Treatment CM | Storage time (months) | L\* | a\* | b\* |
| 1 | 0 | 93.62±0.79b | -2.27±0.23c | 13.63±1.26a | 54.94±3.74c |
| 2 | 6  | 94.65±0.77a | -1.36±0.17b | 10.87±0.48c | 63.07±1.78a |
| 3 | 12  | 94.86±0.81a | -0.86±0.16a | 12.66±0.49b | 58.56±2.02b |

1 L\*, a\*,and b\* according to the CIE lab system.

2Hunter whiteness index. 3means±standard deviation.

4 Means in each column followed by the same letter are not significantly different (p >0.05).

The interaction effect of different types of milk and storage time on the color of the Nabulsi cheese are shown in Table 5. Directly after processing the zero time and 6, and 12 months of storage at room temperature, the results showed significant increase in lightness (L\* ) and whiteness During storage for all sample between storage zero time and 6 month of storage. The highest L\* values and whiteness were for cheese mad of mixing of sheep’s milk and goat’s milk in the ratio of 25:75 CM4 which increased of 94.82±1.0 to 95.83±0.09 and whiteness of 62.24±1.82 to 66.27±0.55 an after 6 months. The preference of treatment CM4 over other treatments in having the whitest color remained after six months of storage. However, after 12 months of storage, there were no significant differences between treatments. This means there are improved for white color of the Nabulsi cheese during storage as evidenced by significantly increased L\*, and whiteness ,while yellowness (b\* coordinate), the low value the cheese of a mixture of( 75% sheep milk,25 goat milk) had it was b\* = 11.26±0.95 zero time and, become 10.15±0.7 after 6 months then increased again yellowness ( b ) to 12.0.60±0.70 after 12 months,while redness a\* to cheese increased significantly ( p<0.05)between storage zero time ,and 6 ,12 months of storage it was for CM4 ( a \* coordinate of -2.10±0.06 at zero time and decreased to-0.94±0.05 after 12 months, storage environment and technological procedure can also change the physical structure of milk resulting in color variations , especially in the case of L\* values (Grigioni, G, et al, 2010).

Table5: The interaction effect between type of milk and storage time on color1 and whiteness index2 of the Nabulsi cheese samples3, 4

|  |  |
| --- | --- |
| Treatments | Color parameters |
| Time period(months) | Types of milk used in processing | L\* | a\* | b\* | Whiteness index |
| Treatment CM | Sheep’s milk (%) | Goat’s milk (%) |
| 0 | 1 | 100 | - | 92.66±2.26b | -2.17±0.14ab | 13.83±1.56a | 53.40±5.25b |
| 2 | - | 100 | 92.85±0.48b | -2.69±0.10c | 13.83±0.71a | 53.57±2.29b |
| 3 | 50 | 50 | 93.96±0.5a | -2.03±0.10a | 14.18±1.03a | 53.88±3.09b |
| 4 | 25 | 75 | 94.82±1.0a | -2.10±0.06a | 11.26±0.95b | 62.24±1.82a |
| 5 | 75 | 25 | 93.80±1.02a | -2.35±0.22c | 15.03±0.96a | 51.59±3.41b |
| 6 | 6 | 100 | - | 94.66±1.13a | -1.28±0.06a | 11.44±0.37a | 61.59±2.12b |
| 7 | - | 100 | 95.02±0.23a | -1.71±0.09b | 10.84±0.38ab | 63.55±1.15ab |
| 8 | 50 | 50 | 93.56±0.66b | -1.25±0.07a | 10.59±0.67ab | 62.60±2.46ab |
| 9 | 25 | 75 | 95.83±0.09a | -1.28±0.12a | 10.15±0.17b | 66.27±0.55a |
| 10 | 75 | 25 | 94.17±0.39b | -1.30±.12a | 11.33±0.91ab | 61.34±2.17b |
| 12 | 11 | 100 | - | 94.98±1.37a | -0.71±0.07a | 13.14±0.73ab | 57.50±2.04ab |
| 12 | - | 100 | 94.72±0.49a | -1.14±.16c | 12.49±0.25ab | 58.67±0.28ab |
| 13 | 50 | 50 | 95.19±0.65a | -0.79±0.09ab | 12.31±0.24ab | 59.80±0.22a |
| 14 | 25 | 75 | 95.94±0.78a | -0.94±0.05b | 12.06±0.70b | 61.40±1.8a |
| 15 | 75 | 25 | 93.47±0.40b | -0.71±0.02a | 13.34±0.44a | 55.45±0.97b |

1 L\*, a\*,and b\* according to the CIE lab system.

2Hunter whiteness index.

3Means ±standard deviation.

4 Means in each column in the same storage period followed by the same letter are not significantly different (P>0.5).

**Effect of adding a starter culture on color of white cheeses**

Observing Cheese color data in Table 6), it is obvious, the made cheese with add starter culture were values (L\* = 88.9 ± 5.4)and Whiteness index 42.227 ,and cheese made without add starter culture was lighter in color and increased values to(L\* = 93.0 ±2.4) and , 50.413 for Whiteness,. Regarding a\*, b\*values, were (a\* =-1.233 , b\* =15.0833 without add starter cultura and with starter culture increased values to 4.2667 , 16.7067respectively

This is an indication that adding starter culture does not have a significant effect on the color of the cheese

Table 6: **Effect of adding a starter culture on color of white**  Nabulsi cheese

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |
| Treatments | L\* | a\* | b\*  | Whiteness index |
| Control (without acidification | 93.24a | -1.233a | 15.0833ab | 50.413c |
| Starter culture (30 incubation) | 88.54b | 4.2667a | 16.7067a | 42.227d |

Means in the same column followed by the same letter are not significantly different (P>0.5).

**Sensory analysis**

The effect of using sheep, and goat’s milk in different ratios on sensory properties of Nabulsi cheese, which affected by the types of milk used is presented in Table7

Cheese color, taste, and texture were significantly affected by milk mixture. Whereas the appearance was not significantly affected. as for color, treatment CM4 (cheese produced by mixing 25% sheep’s milk and 75% goat’s milk) had significant score of 8.38, this maybe attributed to goats’ cheese that is generally whiter than other cheese treatments because of its ability to convert carotene to vitamin A (Park, 2006)

Whereas cheese samples prepared mainly from sheep's milk or cheese produced from mixing 50% sheep’s milk and 50% goat’s milk or cheese produced by mixing 75% sheep’s milk and 25% goat’s milkshowed low score according to cheese coloras for taste that treatment CM1 (cheese produced from sheep’s milk 100) and cheese produced by mixing 75% sheep’s milk and 25% goat’s milk) had the high taste score of 8.23 and 8.03; respectively. Treatments CM2, CM3, andCM4 had significantly lower scores than CM1,because cheese prepared had soft flavor and aroma and a creamy texture due to the presence of the small fat globules that dispersed in the milk(Park, others, 2007) and the free fatty acid levels, which are responsible for this flavor (Jooyandeh and Aberoumand 2010), who reported that no significant effect upon flavor and overall sensory parameters of cheese produced from various ratios of ewes to goat milk but Mallatou et al.( Year), who observed that cheeses manufactured with either 75% GM (1EM:3GM, v/v) or pure GM, about and the best scores for flavor in addition, sheep milk presents a higher rate of hydrolysis for triglycerides containing medium‐chain fatty acids relative to long‐chain fatty acids (Chávarri, and others, 1998). The texture results showed that it is significantly affected by mixing sheep’s and goat’s milks on cheese texture, and noticed that CM5 of cheese produced of using sheep’s milk 75 % and goat’s milk 25% improve the texture as evidenced by its score 7.92, which was significantly ( p<0.05) higher than other treatments including treatment CM1 (cheese made from sheep’s milk and considered as a control treatment) that had 7.4 and treatment number CM2 had lowest score of 5.75 and shown that high acidity, protein, and total solids content generally make cheese harder and less easily deformed

Though most softest cheeses were found to cheese produced from sheep’s milk 100 and the hardest ones were those cheese produced from GM. Freitas et al.(1997) reported contradictory results, the volumetric ratio of EM to GM milk was not statistically significant in terms of its effect upon surface, form and texture.While published Mallatou et al. ( 1994), that cheeses produced from 75% of GM or GM (100%) got the best scores for texture. Table 7: Effect of using sheep’s and goat’s milk in different ratios Sensory properties of Nabulsi cheese

|  |  |
| --- | --- |
| Types of milk used  | Sensory properties1 |
| Treatment CM | Sheep’s milk (%) | Goat’s milk (%) | Color | Appearance | Taste | Texture |
| 1 | 100 | - | 6.67b | 7.45a | 8.03a | 7.40b |
| 2 | - | 100 | 6.43bc | 7.25a | 6.32c | 5.75d |
| 3 | 50 | 50 | 6.33c | 7.50a | 6.83b | 5.93cd |
| 4 | 25 | 75 | 8.38a | 7.17a | 6.53c | 6.02c |
| 5 | 75 | 25 | 6.5bc | 7.45a | 8.23a | 7.92a |

1 Means in each column followed by the same letter are not significantly different (P > 0.05)

**The effect of storage time on sensory attributes score of the Nabulsi cheese are summarized in Table 8** showed that the color and appearance were not affected by storage time (0, 6 , 12 months). On the contrary, taste and texture were significantly affected,as can be seen from taste scores, storage for 6 months significantly reduce the score from 7.36 (at 0 storage time) to 7.09 (after 6 months of storage). Though after 12 months of storage, it increased but insignificantly of 7.12. The WBC texture, was evaluated and it is obvious that storage for 12 months significantly improved the texture score as compared to zero time storage (6.63) and storage for 12 months (7.03). Interestingly, the effect of storage was not consistent as the lowest score was for samples stored for six months.

This result is in consistent with published results found by Maher M , etal.(2014) who found Sensory scores for color, appearance and texture increased significantly (P < 0.05) with the increase in the NaCl in brine concentration during of 1 year of storage.

Table 8: Effect of storage time (regardless of the type of milk used) on sensory properties of the Nabulsi cheese

|  |  |
| --- | --- |
| Treatments | Sensory properties 1 |
| CM | Storageperiod (months) | Color | Appearance |  Taste | Texture |
| 1 | 0 | 6.67a | 7.52a | 7.36a | 6.63b |
| 2 | 6 | 7.12a | 7.36a | 7.09b | 6.15c |
| 3 | 12 | 6.82a | 7.0a | 7.12b | 7.03a |

1 Means in each column followed by the same letter are not significantly different (p>0.05)

Sensory results presented in Table 9shows that interaction effect between the types of milk used and the storage period on sensory properties of the Nabulsi cheese. Treatment CM4 of milk mixture (25% sheep’s and 75% goat’s milk) had the highest significant color score measured after processing ( 0 time) and upon storage for 6 and 12 months were 8.35, 8.65, and 8.15; respectively

The WBBC appearance, after processing directly set as 0 time, it is obvious that there was no significant difference between treatments. However, after six and 12 months there were significant differences between treatments.

The WBC taste, treatment CM1 (cheese made from sheep’s milk) and CM 5 (cheese made from mixing 25% sheep’s milk and 75% goat’s milk) had the highest significant scores at the three storage periods. Of 7.95, 8.00, 7.95 and 8.00 , 8.25,8.45, respectively.

The sensory evaluation (Table9), treatment number CM1 and CM5 had the highest scores at the three storage periods. There was no significant difference between these two treatments at 0 storage time. Whereas after 6 and 12 months, treatment number 5 had a higher significant score in comparison with treatment CM1.

Table 9 The interaction effect between type of milk and storage time on sensory properties of the Nabulsi cheese

|  |  |
| --- | --- |
| Treatments  | Sensory properties 1 |
| Time period (months) | Types of milk used | Color | Appearance | Taste | Texture |
| Treatment CM | Sheep’s milk | Goat’s milk |
| 0 | 1 | 100 | - | 6.35b | 7.30a | 7.95a | 7.40a |
| 2 | - | 100 | 5.58c | 7.55a | 6.70c | 5.80b |
| 3 | 50 | 50 | 6.20b | 7.70a | 7.40b | 5.95b |
| 4 | 25 | 75 | 8.35a | 7.35a | 6.75b | 6.05b |
| 5 | 75 | 25 | 6.60b | 7.70a | 8.00a | 7.95a |
| 6 | 6 | 100 | - | 6.85b | 7.25ab | 8.20b | 6.90b |
| 7 | - | 100 | 6.95b | 6.70b | 6.10c | 5.20c |
| 8 | 50 | 50 | 6.45c | 7.30a | 6.40c | 5.45cd |
| 9 | 25 | 75 | 8.65a | 6.95ab | 6.50c | 5.70c |
| 10 | 75 | 25 | 6.70b | 7.05ab | 8.25a | 7.50a |
| 12 | 11 | 100 | - | 6.80b | 7.15b | 7.95a | 7.90b |
| 12 | - | 100 | 6.50b | 7.50a | 6.15c | 6.25c |
| 13 | 50 | 50 | 6.35c | 7.35a | 6.70b | 6.40c |
| 14 | 25 | 75 | 8.15a | 7.20a | 6.35bc | 6.30c |
| 15 | 75 | 25 | 6.30c | 7.60a | 8.45a | 8.30a |

1Means followed by the same letter are not significantly different.

**Effect of adding a starter culture on Sensory quality of white Nabulsi cheeses**

The results of Sensory quality of the Nabulsi cheese made with addition of starter culture presented in Table 10) it is obvious there were no significant differences between color, appearance and taste for cheese produced by (acidification, 30 min incubation) and without acidification) This result is in agreement with (Mudawi,etal 2016 )who found The color ,Flavor ,texture of cheese made using starter cultures was not significantly affected by the starter culture addition 2.00%, 2.5%, concentration, as for taste, The resultswereinconsistence with that of (Salih and Abdalla)(2020), who found that cheese made with starter culture demonstrated a higher score of taste compared to the cheese made without a starter culture. While Frau et al. (2014) who found that cheese made with commercial starter had a lower score in general acceptance due to its highly acidic taste.

**Table 10Effect of adding a starter culture on Sensoryqualitythewhite Nabulsi cheeses**

|  |  |
| --- | --- |
| Treatments  | Sensory properties1 |
| Number | method  | Color | Appearance | Taste | Texture |
| 1 | Control (without acidification) | 3.1b | 4.5b | 5.0c | 4.5c |
| 2 | Starter culture (30 min incubation) | 3.5b | 4.2b | 4.5c | 5.6b |

 1 Means in each column followed by the same letter are not significantly different (P > 0.05).

**Conclusion**:

Microbial quality not affected by milk type during production or storage whereas, the color and sensory quality varies with milk type and mixing ratio. Additionally, ratios of milk from different animals in milk mixture that influence the produced WBC. A decrease in whiteness index to cheese produced by the addition of starter culture compared to the Control without starter culture.Additionally, no significant differences found between color, appearance and taste for cheese produced with or without adding starter culture .

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