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Incorporation of Different Cheese Slurries into Retentate of Ultra-filtrated White Soft Cheese for Enhancing Flavor and Quality Improvement

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Abstract

One of the most important criteria in any type of cheese is its flavor and texture, which consequently affect its quality, consumer choice and acceptance. The ultra-filtrated (UF) white soft cheese is one of the very popular cheese types in the Mediterranean region. This type of cheese has some properties that do not meet the consumer preferences because of the lack in its flavor and also the texture is not spreadable. So this study aimed to improve the quality and enhancing theflavor of UF-white soft cheese by incorporating different cheese slurries into the prepared retentate for UF-white cheese making and compared with UF- cheese control. The slurries of pickled Domiatti, Roquefort or Mish cheeses were incorporated separately into the cheese retentate with different levels (6, 9 or 12%). Chemical, microbiological, rheological and sensory properties of all resultant UF-white cheese treatments and control were studied during the cold storage at 6$\pm$1ºC. The results showed high values for acidity, total nitrogen, water soluble nitrogen, total volatile fatty acids, salt, ash, fat and total solids in cheese treatments comparing with control during the storage period. Rheological parameters in all cheese treatments were decreased during storage period. The flavor and texture of UF-white soft cheese treatments were improved by using the different cheese slurries. The favorite slurry type was registered for Domiatti cheese, in all added levels as it shows the highest total scores for sensory evaluation along the storage period comparing to other treatments and control.

Keywords: Cheese slurry; pickled Domiatti cheese; Flavor; Mish cheese; Retentate; Roquefort cheese; Ultra-filtrated white soft cheese.

1. INTRODUCTION

Many factors affect cheese flavor and texture widely such; type of cheese, age and fat content….etc.Also metabolism of residual lactose, lactate and citrate; or also liberation of free fatty acids, and the degradation of the casein matrix to a range of peptides and free amino acids are responsible for the development of cheese flavor and texture for most of cheese types [1]. White soft cheese considered as the most popular cheese in the Mediterranean region like Egypt.It is consumed with large quantities and it has many varieties depending on the manufacturing technique, percentage of fat and salt [2]. Using UF-technique for cheese manufacture was successful especially with unripen softcheese types such as Feta, and Quarg cheese[3]. Moreover,UF-technique leads to retention of all or part of whey proteins into the retentateand that increases both the nutritional value and yield of the resultant cheese [4, 5].

Despite the advantages of UF-technique in the production of white soft cheese, there are some cheese properties that do not meet the consumer preferences such as the lack in the characteristic flavor development. This might be related to low hydrolysis of protein and fat; which subsequently affect the cheese texture and flavor development [6].In this type of cheese,the formationof soluble nitrogen during storage was much slower than in the cheese made by traditional method[7, 8].This defect may relate to high retention of whey proteins in UF-white cheese; which may inhibit chymosin, microbial rennet, probably other proteinases and peptidases activity[9].Therefore, various methods and several approaches have been used to improve the flavor and quality of UF-white soft cheese to meet consumer demands; such as adding cheese slurry[10-13].

Cheese slurry is a semi solid paste having around 40% total solids and characterized by distinct flavor [14], where it is considered as a good source of enzymes, small nitrogenous components and free fatty acids [15].Several researchers reported that cheese slurry accelerate ripening of cheese and enhance its flavor through formation of soluble nitrogen, free amino acids, volatile fatty acids and total carbonyl compounds, as well as it improves the sensory properties[11, 16].Blending cheese slurry in UF-cheese curd leads to more and rapid hydrolysis of αs_1-casein than β-casein and also high water soluble

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nitrogen, total and individual free amino acids. In addition, such application was a useful tool for accelerating the proteolysis and flavor development of UF-white soft cheese, due to its effect on the activity of lactic acid bacteria(LAB) and their enzymes during ripening period[13].

The aim of this study is producing UF- white soft cheese with new flavor; by incorporating different types of cheese known with their strong flavor like; Mish cheese, pickled Domiatti cheese and Roquefort cheese and also improving their quality as well as enhancing the flavor. So, in this study different types and ratios of cheese slurries were used as a source of flavor, enzymes and microorganisms to improve the flavor properties of UF-white soft cheese and study their effect on microbiological, chemical, rheological and organoleptic properties.

2. MATERIALS AND METHODS

2.1. Materials

Fresh Ultra filtrated buffalo's milk (UF-retentate)was supplied from the Dairy Processing Pilot Plant (Fac. Agric., Fayoum Univ., Fayoum, Egypt). Three types of cheese were used for making the slurry. Ripened Roquefort cheese ;five month old (Denmark production), six month old ripened Domiatti cheese; were purchased from local market(Fayoum, Egypt)and whole Mish cheese (ten months old) was previously prepared before manufacture. Microbial rennet powder (CHY-MAX, 2280 IMCU/ml) was purchased from Chr. Hansen' Lab.(Denmark). The chemicals used in this study were analytical grade and were purchased from El- Naser and Sigma Companies.

2.2. Methods

2.2.1. Manufacture of whole Mish cheese

Fresh Kariesh cheese and whole Mish cheesewereprepared as described by Abou-Donia[17] andZaki&Shokry[18].

2.2.2. Preparation of Roquefort, Domiatti and Mish cheese slurries

Cheese slurries were prepared immediately before manufacturing as follows:

Different types of cheese; pickled Domiatti, Roquefort and Mish cheese were blended separately for 2-3 min. with part of the retentate in the blender as described by Mostafa *et al*.[10].After mixing each type of cheese slurry, was added separately at ratios of 6, 9 and 12% to the reminder amount of the retentate that prepared for cheese making.

2.2.3. Experimental procedures

UF-white soft cheese was made as described by Renner and Abd El-Salam [19]. Ten different treatments were carried out as illustrated in Fig. (1). Samples of the resultant UF-cheeses were investigated for rheological, chemical lnd organoleptic properties along cold storage period (14 days).

2.2.4. Methods of analysis

2.2.4.1. Chemical analysis

Ash%, fat%, moisture%, total nitrogen (TN%) and water soluble nitrogen (WSN%) of raw materials and resultant UF-white soft cheese samples were estimated as described in AOAC [20][21]. The pH values were measured by using laboratory pH-meter; Thermo Scientific Orion Star (A214). Sodium chloride (NaCl%) was determined by direct titration according to Bradley *et al*. [22]. Total volatile fatty acids (TVFAs)were determined (as milliliters of NaOH (N/10) per 10g of cheese) by the steam distillation method as described by Kosikowski [23].

2.2.4.2. Rheological properties

Texture profile analysis (TPA) was performed in the Dairy Research Department, Food Technology Research Institute, Agriculture Research Center, Egypt. The samples were made using Universal Testing Machine (TMS-Pro).The rheological properties were calculated as described by Bourne [24],Szczesniak [25]and Szczesniak *et al*. [26].Samples were cut into cylindrical cubes 2×2×2 cm and kept at 25°C for 1h before analysis; each sample was subjected to two subsequent cycles (bites) of compression-decompression.

2.2.4.3. Organoleptic properties

All resultant UF-white soft cheese samples were sensory evaluated when fresh and during storage period by ten of the staff members at Dairy and Food Science Departments, Faculty of Agriculture, Fayoum University, Egypt. The cheese samples were evaluated using the following score points: flavor (50 points), Body and texture (35 points) and appearance & color (15 points) according to Hassan *et al*.[27].

2.2.4.4. Microbiological examinations (Log cfu/g)

All media in this study were prepared as described in Oxoid [28]. Total viable counts and spore forming bacterial counts were enumerated with plate count agar medium.While, yeast and mold counts were investigated by using potato dextrose agar medium. Coliform groups were detected on MacConkey's agar medium; Lipolytic and proteolytic bacterial counts of prepared cheese slurry and UF- white soft cheese samples were determined according to APHA [29].

2.2.4.5. Statistical analysis

The obtained results were statistically analyzed by using general linear model of SPSS [30]. Mean of the values, were compared with main effects by Duncan's multiple range tests[31].

3. RESULTS AND DISCUSSION

3.1. Gross chemical composition of raw materials

The main chemical composition of the raw materials was illustrated in **Table (1).**

3.2. Gross chemical composition of UF- white soft cheese samples

3.2.1. Moisture, fat and fat / dry mater contents

The influence of incorporating different types and ratios of cheese slurries on moisture, fat and fat/dry matter (F/DM) contents of UF-white soft cheese during cold storage period were investigated and presented in **Table (2)**. The results revealed that, using slurries of pickledDomiatti, Roquefort or Mish cheeses with different ratios (6, 9 and 12%) in the manufacture of UF-white soft cheese show significant differences ($P \leq 0.05$) in its content of moisture. Generally, it was noticed that, moisture content of UF-white soft cheese samples decreased with increasing the ratio of cheese slurry. It is worth mention that UF-cheese samples made with Roquefort cheese slurries had the lowest moisture content. While, samples of control cheese had the highest moisture content compared to the other UF-cheese samples that contain different cheese slurry, either when fresh or during the storage period. The moisture content in control cheese samples were, 70.54, 70.33 and 70.03%for fresh age, 7 and at 14 days of storage, respectively. The results also show that moisture content in all UF-white soft cheese samples were slightly decreased during storage periods. These results were in agreement with that obtained by**El-Din *et al.* [32]; Abd El-Salam [33]; Kebary*et al*. [34]**. Similar trends in white soft cheese were reported by **Mostafa *et al.* [10]** and **El-Sissi [11, 12].**

The variations in the fatcontent of UF-cheese samples were found to be very significant ($P \leq 0.05$) during storage andbetween treatments. This increase in fat content could be attributed to the gradual decrease of moisture in all UF-white soft cheese treatments throughout the storage period. Similar results were obtained by **El-Sissi [11].**

3.2.2. Titratable acidity (TA %)

Changes in TA % (**Fig. 2**) of UF-white soft cheese incorporated with different types and ratios of cheese slurries were investigated**.** There was a significant difference ($P \leq 0.05$) between treatments and during storage period. The results showed that TA (%) of fresh UF-white soft cheese samples were 0.25, 0.33, 0.31, 0.30, 0.45, 0.47, 0.48, 0.38, 0.39 and 0.39 % for control, D_1, D_2, D_3, R_1, R_2, R_3, M_1, M_2 and M_3 cheeses, respectively. By the end of cold storage period (14 days); TA (%) reached to, 0.37, 0.41, 0.44, 0.47, 0.52, 0.53, 0.56, 0.52, 0.51 and 0.58% for samples of previous treatments, respectively. All cheese treatments exhibited higher acidity values than the control cheese; this could be attributed to whey proteins and the simple nitrogenous compounds of the cheese slurries which stimulate the acid producing bacteria during storage period**.** These results are in agreement with those obtained by **Mostafa *et al*. [10]; El-Sissi [11, 12]; Sudhir *et al*. [35]**.

3.2.3. Salt, salt / moisture and ash contents

The Effect of types and ratios of cheese slurries on the salt and salt/ moisture (%) of UF-white soft cheese during cold storage period at 6±1°C for 14 days, are illustrate in **Table (2)**. There were significant differences ($P \leq 0.05$) between treatments and during storage period. It is evident from the obtained results that the salt and salt/moisture content increased during cold storage period in all cheese treatments, with an opposite trend of cheese moisture **[11]**. The highest percentage of salt was noticed in M3 treatment, which contained 2.67, 3.00 and 3.20% for fresh, 7 and 14 days of storage, respectively. While, the control contained the lowest percentage of salt; 1.68, 1.73 and 1.83, at same previous ages, respectively. It was also noticed that there is a relationship between the moisture and salt content; the lower the moisture content, the higher the salt content of cheese, this also might be due to the effect of different salting method used in each cheese used as a source for preparing the slurry. These results were in agreement with **Akhgar *et al*. [13]**, as they reported that salt percentage of UF-white soft cheese increased when the amount of cheese slurry increased.

Results in **Table (2)**, showed the ash content of UF-white soft cheese treatments, there was a significant difference ($P \leq 0.05$) between UF-white soft cheese treatments and during cold storage period. It is noticed that ash content was increasing in all UF-white soft cheese treatments during storage period. The highest percentages of ash were in M3 treatment where; it was 3.32, 3.58 and 3.73% for fresh, 7 and 14 days, respectively. While, control treatment contained the lowest percentage of ash; being 2.51, 2.59 and 2.69, for fresh, 7 and 14 days, respectively. Similar results were obtained by**Abd El-Hamid *et al*. [36]**.

3.2.4. Nitrogenous parameters

3.2.4.1. Total nitrogen (TN %)

Results in **Fig. (3)** explain the TN (%) of different UF-white soft cheese treatments during storage period. There is a significant difference ($P \leq 0.05$) between UF-white soft cheese treatments made with different types of cheese slurries, also in all UF-white soft cheese treatments there is an increase in TN% during storage period, and that may relate to the decrease in moisture content as storage progressed. Similar trends were obtained by **Kebary*et al*. [34]; Abd El-Salam [33]**

and Akhgar *et al*. [13]. The highest TN content was recorded at the 14^{th} day in UF-white soft cheese treatment that made with 12% pickled Domiatti cheese slurry (D3) which recorded 1.87%, followed by UF-white soft cheese that made with added 12% Roquefort cheese slurry (R3), which recorded 1.86%. However, the lowest TN content was noticed in control which recorded 1.69% at the same previous age.

3.2.4.2. Water soluble nitrogen and Water soluble nitrogen/ total nitrogen (%)

Water soluble nitrogen (WSN %) is regarded as a measure of proteolysis and is commonly reported as percentage of the total nitrogen. The results obtained in **Figs. 4 and 5**, explained WSN (%)and WSN/ TN (%) of UF-white soft cheese samples. The addition of pickled Domiatti, Roquefort or Mish cheese slurries with different ratios (6, 9 and 12%) to the retentate used in the manufacture of white soft cheese has a significant effect ($P \leq 0.05$) on the WSN and WSN/ TN contents. The highest value of WSN% was 0.80 for R3 treatment, while the lowest value was 0.35 for control at 14 days of storage. It is concluded that addition of 12% Roquefort cheese slurry led to an increase in both WSN and WSN/TN% during storage period. This may be due to the high counts of proteolytic bacteria in Roquefort cheese slurry, compared to other cheese slurries (see **Table 5**) which causes protein degradation by peptidases and aminopeptidase either extra and/or intracellular with the formation of soluble nitrogenous compounds namely proteose peptones and amino acids **[12].**

These results were in agreement with that reported by **El-Sissi [11]**; as when they use cheese slurries in the manufacture of pickled Domiatti cheese, leads to an increase in WSN% during the storage period. The results also indicated that the WSN% increased in all cheese treatments as the cold storage period proceeded. This may be attributed to the rate of proteolysis throughout the storage period. Similar trends were obtained by **Mehaia [37, 38]; Kebary*et al*. [34] and Dimitreli *et al.* [39].**

3.2.5. Total volatile fatty acids contents

The changes in total volatile fatty acids (TVFAs) during the storage period for UF- white soft cheese made with different types and ratios of cheese slurries comparing to control were illustrated in **Table (3)**. The results showed that the accumulation rate of TVFAs increased in all cheese treatments during the storage period. These results are in agreement with those reported by **Mehanna *et al*. [40]; Sudhir *et al*. [35]; Kebary *et al*. [34] and Akhgar*et al*. [13].**However, the rate of increasing in TVFAs varied considerably among the cheese treatments depending on the type, ratio of cheese slurry and also the storage period. Furthermore, both the type and proportion of the added cheese slurry have a significant effect ($P \leq 0.05$) on the TVFAs contents. It could be noticed that the contents of TVFAs in white soft cheese produced from retentate incorporated with 6% (R_1), 9% (R_2) or 12% (R_3) Roquefort cheese slurry recorded the highest values along the cold storage period comparing with other UF- cheese treatments. This increase in TVFAs could be due to more lipolysis in this type of cheese, which resulted from *Penicillium roqueforti* as a source of lipolytic enzymes [**1**, **41]**. Also the UF-white soft cheese; with added different ratios of pickled Domiatti cheese slurry followed the previous behaviour in its content of TVFAs. While, that made with added Mish cheese slurry and control cheese had the lowest values either when fresh or during storage period. These results agree with those obtained by **Ammar *et al*. [42]**.

3.3. Rheological properties of the UF-white soft cheese

The changes in rheological parameters during storage periods were determined by the texture profile analyzer **(**TPA**)** in terms of hardness, cohesiveness, springiness, gumminess and chewiness **(Table 4)**.

3.3.1. Hardness

The hardness values in all UF-white soft cheese treatments made by different types and ratios of cheese slurries comparing to control recorded high values either when fresh or at 14 days. The hardness values of resultant cheese were increased as the added ratio of cheese slurry increased. It is worth mention that adding Roquefort and Mish cheese slurries with different ratios to the cheese retentate increased the hardness, especially in fresh age, whereas, the values were, 3.31, 3.88, 4.01, 2.89, 3.45 and 3.78 N for R_1, R_2, R_3, M_1, M_2 and M_3 treatments, respectively. Pickled Domiatti cheese slurry also caused an increase the hardness of the resultant UF- white soft cheese compared with control. By the end of cold storage period the hardness decreased in the control and in all UF-cheese treatments. From these results it can be observed that adding the different cheese slurries to cheese retentate; impart hardness by increasing the total solids (protein and fat). The relative amounts of water, protein and fat were the dominant factors affecting cheese hardness. The decrease in hardness by progress of storage, may related to early hydrolysis of α_{s1}-casein at the Phe_{23}- Phe_{24} peptide bond by residual chymosin which result in a marked weakening of Para-casein matrix and decrease in fracture stress and hardness **[43, 44].**

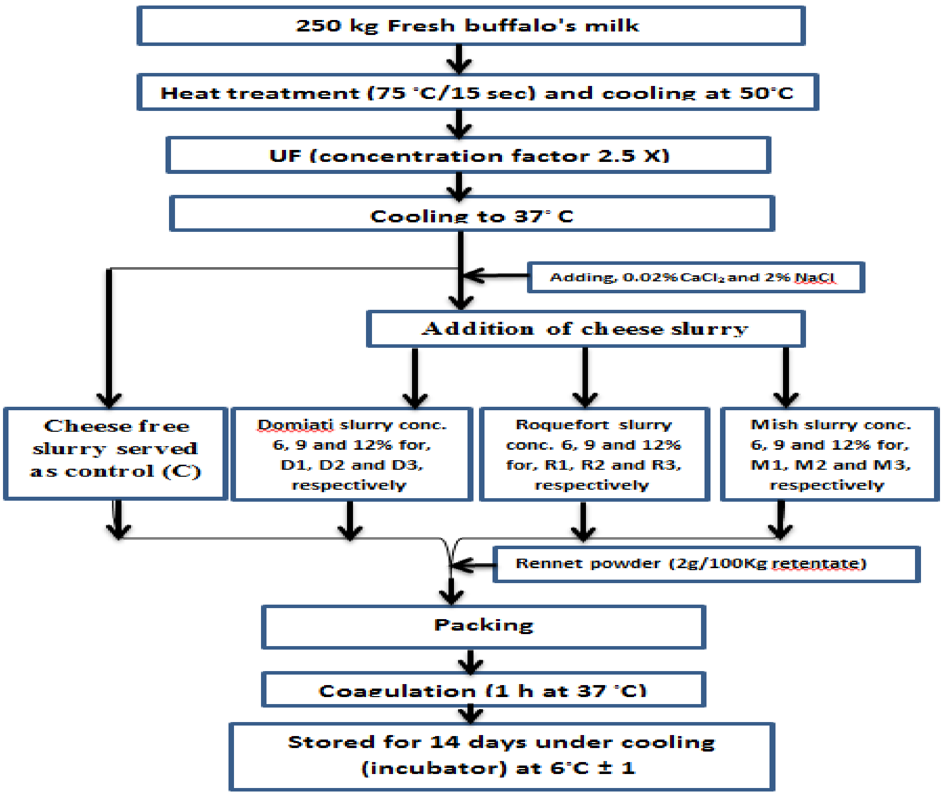

Fig. (1): Flow diagram for making UF- white soft cheese by different cheese slurry

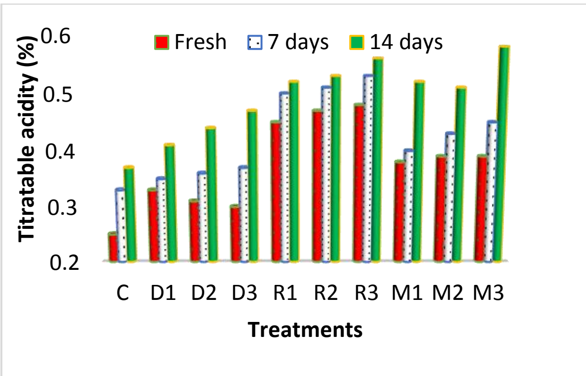

Fig. (2): Titratable acidity (%) of UF-white soft cheese with different cheese slurries during storage at 6±1ºC.

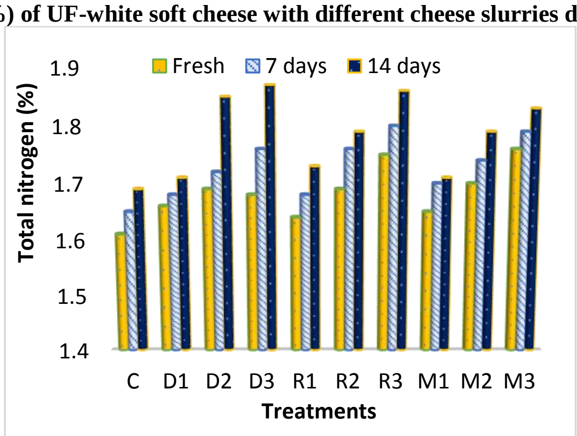

Fig. (3): Total nitrogen content of UF-white soft cheese with different cheese slurries during storage at 6±1ºC.

Table (1):Gross chemical composition of raw materials used in UF-white soft cheese making

Raw Materials	Moisture (%)	Ash (%)	Fat (%)	TP* (%)	Salt (%)	pH values
Buffalo's milk retentate	70.65	1.78	13.30	10.21	ND**	6.6
Roquefort cheese	58.03	3.10	19.00	15.95	2.95	5.4
Pickled Domiatti cheese	53.19	3.80	21.00	13.08	5.10	4.5
Whole Mish cheese	61.56	9.70	2.00	19.53	7.10	5.2

*TP: Total protein **ND: Not determined

Table (2): Effect of using different cheese slurries on chemical composition of UF-white soft cheese during storage at 6±1°C

Treatments	storage period (days)	Moisture (%)	Fat (%)	Fat/ dry matter (%)	Ash (%)	Salt (%)	Salt / moisture (%)
C	**Fresh**	70.54^{a}	13.30^{qr}	45.15	2.51^{l}	1.68^{q}	2.38
	7	70.33^{b}	13.50^{o}	45.50	2.59^{kl}	1.73^{pq}	2.46
	14	70.03^{c}	13.70^{m}	45.71	2.69^{hij}	1.83^{p}	2.61
D_1	**Fresh**	69.38^{d}	14.10^{m}	46.05	2.55^{kl}	2.00^{o}	2.88
	7	69.07^{e}	14.25^{l}	46.07	2.61^{jk}	2.10^{no}	3.04
	14	68.80^{f}	14.45^{k}	46.31	2.72^{fgh}	2.18^{mn}	3.16
D_2	**Fresh**	68.83^{f}	14.20^{l}	45.56	2.58^{kl}	2.11^{n}	3.07
	7	68.50^{h}	14.43^{k}	45.81	2.67^{hij}	2.20^{lmn}	3.21
	14	68.30^{i}	14.75^{i}	46.53	2.73^{fgh}	2.32^{jk}	3.40
D_3	**Fresh**	68.69^{g}	14.50^{i}	46.31	2.62^{ijk}	2.17^{mn}	3.16
	7	68.32^{i}	14.75^{i}	46.56	2.68^{hij}	2.23^{klm}	3.26
	14	67.92^{kl}	15.00^{h}	46.76	2.78^{efg}	2.41^{hij}	3.54
R_1	**Fresh**	67.72^{l}	15.05^{h}	46.62	2.67^{hij}	2.30^{jkl}	3.40
	7	67.60^{m}	15.35^{f}	47.38	2.70^{ghi}	2.50^{gh}	3.70
	14	67.41^{n}	15.48^{e}	47.50	2.75^{fgh}	2.63^{def}	3.90
R_2	**Fresh**	67.00^{o}	15.25^{g}	46.21	2.69^{hij}	2.35^{ij}	3.51
	7	66.80^{q}	15.50^{e}	46.69	2.74^{fgh}	2.43^{hi}	3.64
	14	66.46^{r}	15.70^{d}	46.81	2.81^{ef}	2.51^{gh}	3.77
R_3	**Fresh**	66.10^{s}	15.85^{c}	46.76	2.70^{ghi}	2.49^{gh}	3.77
	7	65.82^{t}	16.00^{b}	46.81	2.78^{efg}	2.55^{fg}	3.87
	14	65.45^{u}	16.25^{a}	47.03	2.84^{e}	2.68^{def}	4.09
M_1	**Fresh**	68.77^{f}	13.14^{s}	42.07	3.26^{d}	2.57^{efg}	3.73
	7	68.43^{h}	13.31^{qr}	42.16	3.45^{c}	2.67^{de}	3.90
	14	68.25^{k}	13.40^{pq}	42.21	3.65^{ab}	2.74^{d}	4.01
M_2	**Fresh**	68.23^{j}	13.28^{r}	41.80	3.28^{d}	2.65^{def}	3.88
	7	67.99^{k}	13.44^{p}	41.99	3.48^{c}	2.89^{c}	4.25
	14	67.76^{l}	13.55^{o}	42.03	3.68^{a}	2.94^{bc}	4.33
M_3	**Fresh**	68.00^{k}	13.30^{qr}	41.56	3.32^{d}	2.67^{de}	3.93
	7	67.72^{l}	13.55^{o}	41.98	3.58^{b}	3.00^{b}	4.43
	14	67.55^{m}	13.67^{n}	42.12	3.73^{a}	3.20^{a}	4.74
SE±		0.03	0.04	-	0.06	0.07	-

a, b,… and u: Means having different superscripts within each column are significantly different ($P \leq 0.05$). **C**: UF-white soft cheese free of slurry (Control),while treatments; **D1, D2, D3, R1, R2, R3, M1, M2** and **M3** were, UF-white soft cheese that incorporated with pickled Domiatti, Roquefort and Mish cheese slurries, respectively (each similar ratios of 6, 9 and 12%),SE: Standard error.

3.3.2. Cohesiveness

In fresh cheese samples; the lowest cohesiveness values were 1.25, 1.28, 1.33 and 1.45 for control cheese (C) and the treatments incorporated with pickled Domiatti cheese slurries at concentrations of 6% (D_1), 9% (D_2) and 12% (D_3), respectively. While, the highest values; were recorded for treatments that contain Roquefort cheese slurries where the values were, 1.55, 1.74 and 1.89 at the same previous age and concentrations, respectively. It is also noticed that the values of cohesiveness for treatments incorporated with Mish cheese slurries were higher than treatments with added pickled Domiatti cheese slurries, but lower than that incorporated with Roquefort cheese slurries. By the end of storage period, cohesiveness values were significantly decreasedfor all cheese samples. Such decrease of cohesiveness may be related to the increase in fat content (as a result of moisture decrease), which reduces the structural integrity of the protein matrix and cheese become less cohesive. These results are conformable with that reported in white pickled soft cheese by **Romeih*et al.* [45]** and **Koca&Metin [46]**.

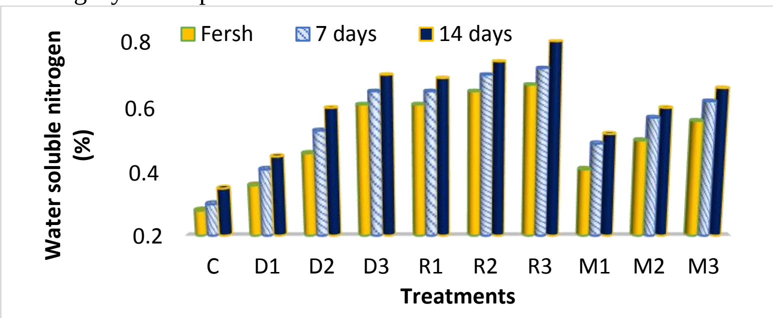

Fig. (4): Water soluble nitrogen content of UF-white soft cheese with different cheese slurries during storage at 6±1ºC.

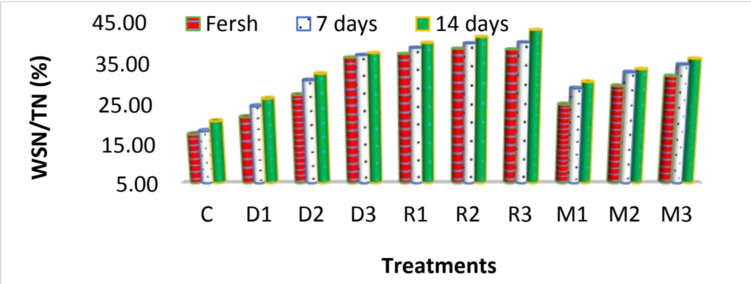

Fig. (5): Changes in WSN/ TN content of UF-white soft cheese with different cheese slurries during storage at 6±1ºC.

3.3.3. Springiness

Springiness values as shown in **Table (4);** for fresh cheese samples were 20.44, 20.75, 19.36, 18.97, 18.24, 17.77, 17.24, 19.2, 18.04 and 17.88 mm for control (C), D_1, D_2, D_3, R_1, R_2, R_3, M_1, M_2 and M_3, respectively**.** From previous results; it is noticeable that in fresh age, all the treatments that incorporated with pickledDomiatti cheese slurries had the highest springiness values compared to the other cheese treatments, but R2 and R3 were less springiness than control cheese. It is worth mention that incorporating the UF-retentate with cheese slurries of Roquefort and Mish at all ratios and also pickled Domiatti cheese slurry at 9% and 12%; led to reduction in springiness comparing to control cheese. This may be due to that relationship between moisture and hardness, and their effects on the protein microstructure existed for springiness and are responsible for the loss in the ability of the cheese to recover to its original state. As the cold storage period advanced to the end (14th day), springiness values were decreased to become 16.50, 16.77, 16.34, 15.88, 15.64, 15.33, 15.01, 16.25, 15.50 and 15.40 mm for pervious treatments in the same order. These results are in agreement with the finding of **Romeih *et al*. [45]** and **Zisu& Shah [47]**. A negative correlation was observed between springiness and storage period. It can be attributed to the release of calcium ions from mono-calcium and di calcium para κ-caseinate molecules that are responsible for the springiness of cheese curd and to the hydrolysis of these molecules during storage **[44]**.

3.3.4. Gumminess

Results in **Table (4)** show gumminess of different UF-cheese treatments. It is noticed that high gumminess values were 3.01, 3.23 and 3.29 N in M3, R2 and R3 treatments, respectively. Such values decreased with progress of cold storage period to be 2.31, 2.49 and 2.58 N for same previous treatments at same order, respectively. From these results it can be observed that ratios of cheese slurry as well as the cold storage period decreases gumminess values in all cheese samples. These results are in accordance with those reported by **Romeih *et al*. [45]**.

3.3.5. Chewiness

Chewiness values in fresh and stored cheese are collected in **Table (4)**. It can be seen that control had the lowest values, while treatment with concentration of 12 % Roquefort slurry possessed the highest one, while, the other treatments had values in-between. It can be concluded that using cheese slurries caused an increase in chewiness values. Although storage for 14 days at 6±1°C caused decrease in cheese chewiness, the control cheese had recorded the lowest value. All cheese samples showed great decrease in chewiness values at the end of storage. These results are in accordance with those reported by **Romeih *et al.* [45]**; **Koca and Metin [46]** and **Zisu & Shah [47].**

Table(3): *Total volatile fatty acids content of UF-white soft cheese as affected by types and ratios of cheese slurries during storage at 6±1°C

Treatments**	Cold storage period (days)		
	Fresh	7	14
C	9.00^{s}	10.00^{r}	12.00^{q}
D_1	18.00^{n}	23.00^{k}	27.00^{g}
D_2	20.00^{m}	25.00^{i}	30.00^{e}
D_3	22.00^{l}	30.00^{e}	38.50^{b}
R_1	24.00^{j}	29.00^{f}	33.00^{d}
R_2	26.00^{h}	30.00^{e}	34.50^{c}
R_3	30.00^{e}	35.00^{c}	45.00^{a}
M_1	9.00^{s}	9.50^{s}	13.50^{p}
M_2	9.00^{s}	10.00^{r}	14.00^{o}
M_3	9.00^{s}	10.50^{r}	18.50^{n}
SE±	0.22		

a, b,…..and s: Means in the same column with different superscript letters are significantly different (P≤ 0.05), SE: standard error,*Total volatile fatty acids (TVFAs) content as milliliters of NaOH (N/10) per 10g, of cheese samples,**See Table (2).

Table(4): The effect of types and ratios of cheese slurry on rheological parameters ofUF-white soft cheese during storage at 6±1°C

Treatments*	Storage Periods (days)	Parameters				
		Hardness (N)	Cohesiveness (~)	Springiness (mm)	Gumminess (N)	Chewiness (mj)
C	Fresh	2.14	1.25	20.44	2.00	50.10
	14	1.80	0.89	16.50	1.50	30.04
D_1	Fresh	2.34	1.28	20.79	2.01	52.07
	14	1.99	0.90	16.77	1.64	30.50
D_2	Fresh	2.60	1.33	19.36	2.25	55.82
	14	2.40	1.10	16.34	1.77	31.66
D_3	Fresh	3.44	1.45	18.97	2.40	55.90
	14	2.80	1.29	15.88	1.80	31.98
R_1	Fresh	3.31	1.55	18.24	2.71	56.67
	14	2.85	1.39	15.64	2.02	32.31
R_2	Fresh	3.88	1.74	17.77	3.23	57.32
	14	3.10	1.53	15.33	2.49	33.43
R_3	Fresh	4.01	1.89	17.24	3.29	57.70
	14	3.38	1.59	15.01	2.58	33.51
M_1	Fresh	2.89	1.40	19.21	2.36	56.03
	14	2.30	1.22	16.25	1.89	31.89
M_2	Fresh	3.45	1.62	18.04	2.95	56.88
	14	2.75	1.44	15.50	2.19	32.56
M_3	Fresh	3.78	1.72	17.88	3.01	56.90
	14	2.94	1.49	15.40	2.31	32.88

***See Table (2).**

It could be concluded that incorporation of cheese slurry into retentate led to proteolysis of the cheese causing changes in the rheological parameters [**13]**. It could be noticed from previous results that, all textural properties decreased with increasing storage. This can be attributed to the weakening of the protein matrix due to the proteolytic action of the enzymes [**48**, **49**], which is confirmed by the increasing values of the %WSN/TN (**Fig. 5**). The short protein molecules reduce the density of the three-dimensional protein matrix in such a way that by the application of stress, the matrix is easily destroyed. Similar results were reported for white soft cheese by **Dimitreli*et al.* [39].** Furthermore, it was found that increasing the levels of cheese slurries; resulted in decrease of the hardness, cohesiveness, gumminess and chewiness of the cheese samples. This might be due to the high ratios of the cheese slurries giving cheese a softer texture.

3.4. Microbiological examination of UF-white soft cheese

The total viable counts (TVC), Yeast and mould counts, spore forming bacteria and Proteolytic and lipolytic bacterial counts of all UF-white soft cheese treatments are shown in **Table (5).** It is noticed that the TVC was increasing during storage period and it reaches its maximum by the end of storage. The lowest numbers were, 5.59, 6.92 and 7.18 log cfu /g in UF- white soft cheese treated with 6% of Roquefort cheese slurry (R2) at fresh, 7 and at 14 days old, respectively. While, the highest one was 7.42 log cfu/ g in UF-white soft cheese treated with 6% of pickled Domiatti cheese slurry. The addition of cheese slurry had stimulatory effect of TVC in fresh treated cheeses. These results agreed with those reported by **Ammar *et al.* [42]**. Yeast and mould counts as recorded in **Table (5)** were increased gradually during storage. From these results it is noticed that cheese control recorded the lowest reading, while, the highest readings were for the treatment that contains 12% Mish slurry (M_3) along storage period. Spore forming bacterial counts are shown in **Table(5)**, which its number increased in all cheese treatments during the cold storage period and the highest number was present in the UF- white soft cheese (control) at 14th day; this might be attributed to the lower salt and acidity in such cheese samples. These results were disagreement with **El-Sissi [11, 12].**From the obtained results no proteolytic or lipolytic bacteria were detected in the fresh age or at 7 days old. On the other hand, at 14th days of storage, the proteolytic and lipolytic bacteria were detected. The UF-cheese incorporated with Roquefort cheese slurry registered the highest numbers comparing with all other cheese treatments, followed by that made with pickled Domiatti cheese slurry. On the other hand, samples made with pickled Domiatti and Mish cheese slurries registered low numbers of both proteolytic and lipolytic bacterial counts. These results were disagreement with that reported by **Mostafa *et al*. [10];** and **Kebary*et al*. [34]**.

3.5. Organoleptic properties of the UF-white soft cheese incorporated with different slurries

The sensory characteristics of different UF-white soft cheese samples and control cheese are shown in **Table(6).** UF-white soft cheese flavor and overall scores were statistically ($P \leq 0.05$) affected by the type and ratios of cheese slurries, while the judgments did not show any significant differences in colour and appearance score by incorporation of pickled Domiatti cheese slurry and also during storage compared with control samples. Addition of 6, 9 or 12% pickled Domiatti cheese slurry to UF-white soft cheese improved its flavor compared with control and characterized as a good flavor, tasty, creamy and farm cheese-like. While control cheese was characterized by the lack (or flat) in the flavor development, this may be due to little protein and fat hydrolysis which subsequently affect the cheese flavor and texture development **[6]**. Resultant fresh cheese samples of D_3 gained the highest scores for overall acceptability (95.29) followed by D_2 (94.97) and D_1 (94.50), white cheese samples produced from M_1 and M_2 gained very close scores to the control. The obtained results recorded that total scores of cheese treatments were improved by increasing pickled Domiatti or Mesh cheese slurries and obviously increased with progressing of storage period, except for increasing Roquefort cheese slurry improved the flavor during storage up to the 7th day and then decreased gradually till the end of the storage, because it caused an increase in bitterness taste scores especially at the end of storage period, Similar trends were reported by **El-Alfy*et al*.[49]**.

Table(5): Counts of microorganisms (log cfu/g) in UF-white soft cheese incorporated with different cheese slurries during storage at 6 ±1°C

Treatments*	Storage period (days)	Total viable counts	Yeast &Mould counts	Spore forming bacterial counts	Proteolytic bacterial counts	Lipolytic bacterial counts
C	**Fresh**	6.36^{de}	3. 39^{l}	1.93^{g}		
	7	6.53^{cd}	3.59^{jk}	2.05^{fg}	ND	ND
	14	7.24^{ab}	4.62^{f}	2.83^{abc}		
D_1	**Fresh**	6.30^{def}	3.45^{k}	2.13$^{d..g}$		
	7	7.02^{ab}	3.75^{hi}	2.65$^{a..f}$	ND	ND
	14	7.19^{ab}	4.81^{e}	2.75^{abcd}		
D_2	**Fresh**	5.87^{gh}	3.50^{jk}	2.14$^{d..g}$	ND	ND
	7	6.57^{cd}	3.75^{hi}	2.63$^{a..f}$		
	14	7.33^{a}	4.84^{e}	2.73$^{a..e}$	1.893	1.893
D_3	**Fresh**	6.56^{cd}	3.53^{jk}	2.36$^{b..f}$	ND	ND
	7	6.60^{cd}	3.79^{gh}	2.43$^{a..g}$		
	14	7.42^{ab}	4.73^{ef}	2.86^{abc}	3.100	3.100
R_1	**Fresh**	5.59^{h}	3.54^{jk}	2.32$^{b..g}$	ND	ND
	7	6.92^{bc}	3.63^{i}	2.33$^{b..g}$		
	14	7.18^{ab}	4.63^{f}	2.54$^{a..g}$	3.09	3.23
R_2	**Fresh**	5.95^{fgh}	3.55^{jk}	2.32$^{b..f}$	ND	ND
	7	6.51^{cd}	3.75^{hi}	2.64$^{a..f}$		
	14	7.27^{ab}	4.61^{f}	2. 82^{a}	3.94	4.10
R_3	**Fresh**	5.90^{fgh}	3.91^{gh}	2.34$^{b..g}$	ND	ND
	7	6.54^{cd}	3.92^{g}	2.51$^{a..g}$		
	14	7.36^{a}	5.60^{b}	2.86^{a}	4.11	4.35
M_1	**Fresh**	6.06^{efg}	4.62^{ef}	2.03^{fg}		
	7	6.55^{cd}	5.36^{c}	2.32$^{b..g}$	ND	ND
	14	7.32^{ab}	6.33^{a}	2.45$^{a..g}$		
M_2	**Fresh**	5.87^{gh}	4.69^{ef}	2.26$^{c..g}$		
	7	6.50^{cd}	5.39^{c}	2.50$^{a..g}$	ND	ND
	14	7.38^{a}	6.43^{a}	2.58$^{a..g}$		
M_3	**Fresh**	6.01^{efg}	5.12^{d}	2.40$^{a..g}$	ND	ND
	7	6.53^{cb}	5.44^{c}	2.53$^{a..g}$		
	14	7.34^{a}	6.48^{a}	2.70$^{a..f}$	1.99	2.34
SE±		0.13	0.05	0.20	-	-

*See Table (2), SE: Standard error, ND: Not determined, a, b, and l: Means in the same column with different superscript letters are significantly different ($P \leq 0.05$).

Table (6):Organoleptic properties of UF-white soft cheese made with different types and ratios of cheese slurries during storage at 6±1°C

Treatments*	Storage period(days)	Flavor (50)	Body & texture (35)	Color & appearance (15)	Total (100)
C	**Fresh**	42.44^{d}	33.11^{a}	14.27^{abcd}	90.11^{def}
	7	43.07^{cd}	33.07^{a}	14.56^{abc}	90.71^{cde}
	14	44.46^{abcd}	32.91^{a}	14.57^{abc}	91.64$^{a..e}$
D_1	**Fresh**	46.40^{abc}	33.60^{a}	14.46^{ab}	94.50^{abcd}
	7	47.21^{a}	33.50^{a}	14.50^{abc}	95.43^{abcd}
	14	47.46^{a}	33.55^{a}	14.71^{a}	95.46^{abcd}

D_2	**Fresh**	47.00^{ab}	33.18^{a}	$14.09^{a..e}$	$94.97^{a..e}$
	7	47.43^{a}	33.86^{a}	14.57^{abc}	95.86^{abc}
	14	47.30^{a}	34.30^{a}	14.90^{a}	96.50^{a}
D_3	**Fresh**	47.00^{ab}	33.64^{a}	14.27^{abcd}	$95.29^{a..d}$
	7	47.64^{a}	33.55^{a}	14.64^{ab}	$95.46^{a..d}$
	14	47.50^{a}	34.20^{a}	14.70^{a}	96.40^{ab}
R_1	**Fresh**	46.21^{abc}	33.21^{a}	$13.64^{a..f}$	$93.07^{a..e}$
	7	$45.70^{a..fd}$	33.60^{a}	$13.90^{a..f}$	$93.20^{a..e}$
	14	36.91^{e}	30.73^{bc}	11.82^{j}	79.46^{f}
R_2	**Fresh**	$44.86^{a..d}$	32.93^{a}	$13.21^{b..g}$	$91.00^{a..e}$
	7	$44.70^{a..d}$	33.60^{a}	$13.70^{a..g}$	$92.00^{a..e}$
	14	35.70^{e}	30.70^{bc}	11.80^{j}	78.20^{f}
R_3	**Fresh**	$44.93^{a..d}$	32.64^{a}	$13.29^{b..e}$	$90.86^{b..e}$
	7	43.50^{bcd}	33.60^{a}	$13.70^{a..g}$	90.80^{cde}
	14	34.46^{e}	30.27^{c}	11.64^{j}	76.36^{f}
M_1	**Fresh**	$44.30^{a..d}$	33.00^{a}	$13.30^{b..g}$	90.60^{cde}
	7	$45.43^{a..d}$	33.14^{a}	$12.79^{e..i}$	$91.36^{a..e}$
	14	$45.27^{a..d}$	33.73^{a}	12.55^{ghi}	$91.55^{a..e}$
M_2	**Fresh**	$44.64^{a..d}$	33.07^{a}	$12.86^{e..i}$	90.57^{cde}
	7	$45.10^{a..d}$	33.60^{a}	$13.30^{b..g}$	$92.00^{a..e}$
	14	$46.00^{a..d}$	33.36^{a}	$12.82^{e..i}$	$92.18^{a..e}$
M_3	**Fresh**	$44.00^{a..d}$	32.55^{ab}	12.36^{hi}	88.91^{e}
	7	$46.00^{a..d}$	33.00^{a}	$12.86^{e..i}$	$91.86^{a..e}$
	14	$45.60^{a..d}$	33.90^{a}	$13.00^{d..h}$	$92.50^{a..e}$
SE±	**Fresh**	0.94	0.58	0.36	1.45
	7	1.17	0.72	0.45	1.81
	14	1.08	0.66	0.41	1.63

a, b,….and i: Means in the same column with different superscript letters are significantly different ($P \leq 0.05$),
SE: standard error,*See Table (2) .

4. Conclusion

Cheese slurry is a semi solid paste having around 40% total solids and characterized by distinct flavor, where it is considered a good source of enzymes, small nitrogenous components and free fatty acids**.** It accelerates ripening of cheese and enhance its flavor through formation of soluble nitrogen, free amino acids, volatile fatty acids and total carbonyl compounds, as well as it improves the sensory properties. Therefore, blending cheese slurry in UF-cheese curd leads to more and rapid hydrolysis of αs_1-casein than β-casein and also high water soluble nitrogen, total and individual free amino acids. In addition, accelerating the proteolysis and flavor development of UF-white soft cheese, due to its effect on the activity of lactic acid bacteria (LAB) and their enzymes during ripening period. So it was found that flavor and texture of UF-white soft cheese was improved by incorporating different ratios of pickled Domiatti cheese slurry or Roquefort cheese slurry at concentrations of 6 or 9% to give desirable flavor till 7 days of storage as well as, Mish cheese slurry can be used at ratios of 6, 9 or 12% because as it gives good flavor as storage period progressed. It is also noticed that incorporation of cheese slurry into cheese retentate led to proteolysis of the cheese causing changes in the rheological parameters; as all textural properties decreased with increasing storage. This can be attributed to the weakening of the protein matrix due to the proteolytic action of the enzymes, which is confirmed by the increasing values of the %WSN/TN. Furthermore, it was found that increasing cheese slurries concentration resulted in decrease of the hardness, cohesiveness, gumminess and chewiness of the cheese samples. This might be due to the high ratios of the cheese slurries giving cheese a softer texture.

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