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IMPROVING THE MELTABILITY AND STRETCHABILITY OF WHITE BRINED CHEESE USING ENZYMATIC AND CHEMICAL MODIFICATIONS TO PRODUCE HIGH QUALITY KUNAFA AND OTHER POPULAR LOCAL SWEETS AND PASTRIES

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ABSTRACT

White brined cheese (WBC) is widely consumed in the Mediterranean and Middle East countries. It is found in different names according to its origin. The white color is mainly due to the absence of carotenoids when cheese is made from goat or sheep's milk. However, cheeses produced from bovine milk have white-yellowish color. Nabulsi cheese is one type of WBC that is widely consumed in Jordan as the main traditional cheese. The incorporation of Nabulsi cheese to produce high quality Kunafa and other traditional sweets and bakery products requires an acceptable level of meltability and stretchability.

Nabulsi cheese is manufactured from goat, sheep or bovine milk and the resulted curd is boiled and stored in brine solution. Some key points to be taken into consideration during the manufacture of Nabulsi cheese are acidification of curd at optimum time and rate, development of pH during ripening and total submersion of cheese blocks in the containers. Its stretchability and meltability could be improved by enzymatic or chemical modification of the curd as proven in literature. Therefore, it is critically important to consider these two factors when enhancing the meltability and stretchability in order to fit in the production of high quality Kunafa.

KEYWORDS: *White Brined Cheese, Meltability, Stretchability*

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INTRODUCTION

In Mediterranean and neighboring countries, brined cheeses are the most important family of cheeses. The processing method, organoleptic properties and composition of each type of cheese that belongs to the family of cheeses in these countries represent the main difference between each type despite their similarities in other prospects (Alichanidis and Polychroniadou, 2008). White cheeses are easily digested as a result of long ripening process which helps in giving the cheese a high concentration of short to medium-chain fatty acids. The higher content of these fatty acids helps in giving the semi-hard to hard texture. The white color, which gives the name to this family, is due to the absence of carotenoids since cheese is mainly produced from goat or sheep's milk (Alichanidis and Polychroniadou, 2008; Blažić *et al*., 2017).

Nabulsi cheese in Jordan is the most common WBC and considered as the main traditional one. Prior to the production of some traditional sweets (in particular Kunafa) and bakeries, Nabulsi cheese is usually desalted (Humeid *et al*., 1990).

In order to produce high quality Kunafa, Nabulsi cheese should impart some functional properties particularly meltability and stretchability. Unfortunately, the use of high quality milk to produce such type of cheese will not give these properties, since a minimal spontaneous fermentation exists in milk and in the curd before boiling (Hassan, 2007). Meltability is the tendency of the cheese to flow and spread upon heating (Gunasekaran and Ak, 2003). On the other hand, stretchability is the tendency of melted cheese to form fibrous strands upon pulling with no breakage during elongation.

The concept of making WBC meltable and stretchable with that both properties are highly demanded to enhance the properties of Kunafa as well as other desserts and baking goods. Therefore, this review aims to discuss the effect of chemical and enzymatic modification on WBC to manufacture high-quality Kunafa in terms of meltability and stretchability.

Brined Cheese

In Middle East, East-Mediterranean and other neighboring countries, brined cheese is the most important group of cheeses. Cheeses of this group are somehow similar, yet some points of dissimilarities exist such as the mechanical and organoleptic properties, protocols of manufacture and composition (Alichanidis and Polychroniadou, 2008). The main points of similarities are the storage and ripening in brine solution up to the point of consumption.

Cheeses of this family could be divided into two groups based on the processing protocols and other properties; (1) “WBC”, in this group, the curd is not exposed to heat treatment. (2) “Miscellaneous brined cheese”, the curd in this group should be exposed to various heat treatments (Alichanidis and Polychroniadou, 2008). However, regardless of the group to which cheeses belong, each type is distinct in terms of organoleptic properties and the technology used to produce each type (Alichanidis and Polychroniadou, 2008; Blažić *et al*., 2017).

White Brined Cheese

WBC is known in different names according to the region in which they are produced. WBC is known as Telemea/Branza de Braila in Romania; Domiati, Mish in Egypt; Bjalo salamureno sirene/Bjalo sirene in Bulgaria; Pljevaljski, Polimsko-Vasojevaski, Ulcinjski in Montenegro; Feta, Telemes in Greece; Akawi in Lebanon; Beyaz peynir, Edirne peyniri in Turkey; Liqvan, Iranian white in Iran; Mohant in Slovenia; Sjenicki, Homoljski, Zlatarski, Svrljiški in Serbia; and Travnicki/Vlasicki in Bosnia-Herzegovina (Alichanidis and Polychroniadou, 2008).

Characteristics of White Brined Cheese

When made from goat, sheep or buffalo’s milk, WBC is pure white in color (marble-white or porcelain-white). However, when made from bovine milk, cheese color turns into off-white to yellow. The cheese matrix should not contain any rinds, gas holes or openings. Defects are considered when small or large gas holes are present. Smoothness, softness, crumbliness and sliceability are textural characteristics of WBC. However, brittleness might occur in some old WBC (Alichanidis and Polychroniadou, 2008).

Manufacture of White Brined Cheese

To manufacture WBC, raw milk (ewe, buffalo, cow or goat or their mixture) is pasteurized at 72°C for 15 minutes or at 63°C for 30 minutes (El-Salam and Alichanidis, 2004). Most of the WBC is coagulated with rennet and brine-salted. However, some types are dry-salted such as Feta while others, as in the case of Domiati cheese, the salt is directly added (El-Salam and Alichanidis, 2004).

Key Points in the manufacture of White Brined Cheese

Acidification of Curd at Optimum Time and Rate

This point is critically important especially during the early steps of cheese production, in particular during curdling and/or draining. During this stage, the formation of lactic acid is of great importance. Growth of the microorganisms responsible for forming gas blowing might not be inhibited by too low or too slow acidification, which may cause a defect especially in cheeses made from raw milk. In contrast, the development of some defects such as lower yield, grainy or dry hard cheeses (with no cohesion) may result from too high or too fast acidification of curd, particularly in cheeses made from cow or goat's milk (Alichanidis, 2007).

Development of pH During Ripening

After 24 hours of coagulation, it is of great importance for most WBC to have a pH value of less than 5.0, salt-in-moisture content of ~25 g L^{-1} and moisture of less than 600 g kg^{-1}. When the pH reaches ~4.6 or less, salt-in-moisture content reaches 50 g L^{-1} and moisture level reaches ~550 g kg^{-1}, cheese should be transferred to a cold room with a temperature of 4–5°C (Alichanidis, 2007).

Total Submersion of Cheese Blocks in Containers

This step is must to ensure that the addition of brine is sufficient in quantity. The salt-in-moisture content should be at least 2% lower than the salt concentration of the brine (Alichanidis, 2007).

Enzymatic Modifications

Enzymes are widely used in many applications of the food industry, mainly due to their ability to modify and enhance the sensory, functional and nutritional characteristics of ingredients and products. In addition, they could be used through several stages from processing till production for all types of food products (Law, 2009).

Enzymes used for the production of cheeses, yogurt and other milk products are known as "Dairy Enzymes". They have several functions, such as coagulants to produce cheese, bioprotective agents to enhance safety and increase the self-life of dairy products. Proteases, esterases, lipases, catalase and lactase are examples of well-known enzymes used in the dairy industry. In the first stage of cheese production, rennet (mixture of pepsin and chymosin) is employed to coagulate milk. On the other hand, proteases of different types are widely employed in many different steps of cheese making; such as accelerating the ripening process and modifying the functional characteristics. Whereas, lipases are mainly utilized in ripening to produce lipolytic flavors. In addition, lactase is important as a digestive aid by hydrolyzing lactose to produce glucose and galactose and to enhance the sweetness solubility of many dairy products (Qureshi *et al.*, 2015).

Many studies have dealt with the utilization of enzymes in cheese manufacturing. The enzymatic modification of cheese by two species of *Aspergillus* was studied by Marzieh *et al*. (2009). Their findings indicated that lipase activity of *Aspergillus oryzae* and *Aspergillus niger* was 43.3 U/g and 10 U/g (U = 1 µmol/min), respectively. Whereas, *A. oryzea* and

A. niger had proteolytic activity of 143 U/g and 38 U/g, respectively. The best score of odor and flavor was obtained after 3 days of storage from both species. Nevertheless, cheese with the flavor was obtained from *A. oryzea* after 3 days of storage. However, cheese treated with the other species just had a strong odor. Concluding that mixture of both species could be utilized to produce enzyme modified cheese with better flavor and short ripening time.

The influence of proteases on melting and stretching ability of Nabulsi cheese was investigated by Hejazin *et al*. (2009). In their study, six commercial proteases were utilized. The concept of the study was built on the hypothesis that meltability and stretchability could be obtained by adding proteolytic enzymes to the original brine that may affect the cross-linking bonds in casein. Papain-treated Nabulsi cheese had superb fibrous structure, making it possible for the cheese to be used in Kunafa, pastries and pizza. The papain-treated cheese had excellent meltability and stretchability even after 4 weeks of storage. Concluding that high salt concentration (18%) in brine used for storage might be a reason for the restricted enzyme activity.

Transglutaminase enzyme (TG) was used in the production of rennet coagulated cheese (Metwally *et al*., 2018). Milk was kept for 30 minutes after the rennet addition to milk at 5°C. Afterwards, TG was added to the milk and the mixture was left for 2 hours after which the temperature was raised to 40°C for coagulation. Two concentrations of TG (0.02 and 0.05%) were used to produce Mozzarella cheese (low and high fat). Functional properties of cheese as well as sensory properties and chemical composition were determined after 28 days of storage at 5°C. Results indicated that meltability, stretchability and yield were increased and protein and fat were recovered. Regarding low fat cheese, in 0.02% TG-treated cheese, meltability, stretchability and yield increased by 50%, 40% and 8%,respectively. On the other hand, in 0.05% TG-treated cheese, the meltability, stretchability and yield increased by 66%, 60% and 15.1%, respectively.

With respect to high fat cheese, meltability, stretchability and yield in 0.02% TG-treated cheese increased by 32.6%, 25% and 7.5%, respectively. Whereas increased by 32.7%, 37.5% and 13.3%, respectively. When compared to the control, TG-treated cheese was more accepted in terms of organoleptic properties (Metwally *et al*., 2018).

Chemical Modifications

The effect of emulsifying salts on the microstructure and other properties of processed cheese were studied by Marijana *et al*. (1985). Emulsifying salts (also known as emulsifying agents) such as polyphosphates, sodium phosphates and citrates are frequently used in the production of processed cheese. They are used either alone or in combination (mixture) and play a major role in sequestering calcium in natural cheese. Other functions include, enhancing the solubilization and increasing the swelling and hydration of proteins, stabilizing and adjusting pH, and facilitating fat emulsification. In addition, due to the introduction of phosphorus and sodium into processed cheese, phosphates and polyphosphates have raised nutritionists concern, since, a trend is being followed to exclude sodium or reduce its concentration in foods. The ultimate standards for processed cheese are consumer acceptance and chemical composition.

The effect of pH on the microstructure of processed cheese and protein interactions were studied by Marchesseau *et al*. (1997). To understand the effect of pH, a number of rheological and microscopic techniques were used to evaluate the biochemical properties such as water-holding capacity, solubilization of casein and peptization coefficient. Their findings showed that entrapment of spherical fat particles with diameters of 2–3 µm was due to the formation of regular tridimensional network in response to adjusting the pH values between 5.7 and 6.0 during the production of processed cheese. However, no protein aggregation was found. The springiness and elasticity of the gel were enhanced by the non-covalent bonds (forces that play a major role in gel cohesion) formed at the pH range of 5.7–6. Substantial modifications

during cheese production were induced by small changes in ionic strength and composition as well as in pH. The aforementioned modifications had considerable effect on the final structure.

The influence of adjusting pH on the melting and stretching abilities of Nabulsi cheese was investigated by Mazahreh *et al*. (2009). The adjustment of pH which may act on the cross-linking bonds of casein and therefore enhancing meltability and stretchability formed the basis of their study. The adjustment of pH from 5.4–5.8 by the addition of citric acid produced low but acceptable levels of stretchability and meltability. Storage of cheese for few weeks and the cheese buffering capacity to reach equilibrium were considered.

CONCLUSIONS

Several enzymes could be used to improve the meltability and stretchability of WBC by their action on the cross-linking bonds of casein. The restriction proteolytic activity of proteases used for this purpose might be attributed to the effect of brine solution used for storage. Papain could be a better choice as well as TG in minute concentrations. Chemical modifications have considerable effect on the melting and stretching abilities of WBC such as the addition of emulsifying salts and pH modification. The latter may act on the cross-linking bonds of casein and the adjustment of pH values to a certain range may cause the entrapment of fat particles without protein aggregation. Emulsifying agents (salts) may have a major role in sequestering calcium and enhancing the hydration and welling of proteins.

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