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# Influence of Using Taro Peels Mucilage on Low-Fat White Cheese Properties

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## ABSTRACT
Easily sourced mucus from various plant parts and their byproducts is an odorless, colorless, and tasteless substance with emerging commercial potential in food, cosmetics, and pharmaceuticals due to its non-toxic and biodegradable properties. Taro corms byproduct has a good amount of mucilage (TPM) which is considered a product that has unique rheological properties with considerable potential as a food thickener and stabilizer. The use of this mucilage is interesting for the dairy industry. The objective of this study aimed to improve the properties of low-fat soft white cheese by using (TPM) at different rates (0.2%, 0.4%, and 0.6 %) compared with full-fat soft white cheese and low-fat soft white cheese without mucilage. The obtained results revealed that (TPM) had 7.42, 0.67, 8.27, 3.44, 0.41, and 80.20% of moisture, fat, protein ash, crude fiber, and total carbohydrate, respectively. Meanwhile, Total phenols content and antioxidant activity were 29.52 mg/g and 30.12%, respectively. On the other hand, emulsion capacity % and water absorption (g water/g) were recorded at 24.18 and 20.33, respectively. Concerning, the chemical, physical characteristics, and texture profile of soft cheese and its treatment using taro peels mucilage. The obtained results indicated that there are significant differences between all different technological treatments and storage periods in the chemical components and physical properties, and it was noticed that the increment of the percentage rate of the taro peels mucilage added to different treatments, led to an increase in the moisture, protein, ash and total phenolic compounds content, along the storage periods compared with the control sample (1 and 2). Antioxidant activity values increased with the increment of mucilage which was considered a rich source of total phenolic compounds as shown by the same results. As for, the microbiological analysis of low-fat white cheese, all samples were in compliance with the microbial limits, moreover, the results revealed that treatment 2 (using 0.4% TPM) recorded the highest values for the degree of overall acceptability, and it was the most desired one for the panelists. It could be concluded that mucilage can improve the functional and organoleptic properties of low-fat white soft cheese as well as enhance the nutritional content.

***Keywords:*** Low-fat white cheese, Taro peels mucilage, Chemical composition, Texture profile, Sensory evaluation.

## 1. Introduction
Cheese is the greatest part of the dairy market in Egypt; it represents about 40% of the total market value. Traditional dinner for Egyptians usually contains white cheese and bread (Euromonitor International, 2012). Soft white Cheese is one of the most popular types of cheese consumed in Egypt, Cheese is an integral part of the diet for Egyptian consumers as mentioned by Abd El-Salam and Benkerroum, (2007). Tallaga cheese is Egyptian unripened white soft cheese consumed within two weeks which is favorable for several consumers due to its nutritional value, good test, and clean pleasant creamy low salty test with spreadable mellow soft body (Mehanna and Rashed, 1990)

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Today, the dairy industry is facing the challenge of producing a product for the health of conscious consumers and also for patients suffering from heart disease, obesity, diabetes, and other diseases, which can be achieved by reducing milk fat, however, reducing milk fat produces undesirable texture and less acceptability cheese. To obtain attributes similar to full fat by using fat substituents or additives must be used (Ali *et al.,* 2016). Since it is well known that dietary habits are directly related to human health maintenance, the application of bioactive compounds as functional food ingredients has met recent consumer demand for products of natural origin. The consumption of these products can promote health and well-being by modulating metabolic processes, and protecting humans against health disorders (Mitsuoka, 2014).

Functional compounds have been extracted from various natural sources, including animals, plants, algae, microalgae, microbes, food, and food by-products, in response to the growing demand for natural goods that improve human health (Herrero *et al*., 2006). Bioactive phytochemicals, found in plants, are abundant and can take many different forms, including sterols, carotenoids, isoflavones, proteins or peptides, and more (Abuajah, *et al*., 2015). Numerous wastes are produced during the processing of various fruit and vegetable products, which may contribute to contamination of the environment. The term "taro" refers to the corms and tubers of various *Araceae* plant species. *Colocasia esculenta* is the most commonly grown of them. Southeast Asia is the native home of taro (Kolchaar, 2006).

Taro is a root crop grown in most tropical areas, and it is one of the famous vegetables grown and processed in Egypt. Large amounts of solid wastes, the rhizome from the taro plant can contain significant levels of mucilage, averaging between 6.84 g per 100 g (Tavares, *et al*., 2011) depending on the extraction method. This mucilage has a viscous appearance and light color. Several studies have shown that mucilage extracted from taro amadumbe possesses anti-hyperglycemic, anti-oxidative, and anti-obesogenic potentials (Nguimbou *et al*., 2014; Hajian *et al*., 2016). Also, the possible use of these mucilage extracts as dietary component supplements for managing hyperglycemia, overweight, and obesity (Chukwuma *et al*., 2018). According to (Lin and Huang, 1993; Tavares *et al*., 2011) the mucilage from vegetables such as taro has emulsification and/or stabilization properties. It has a wide range of applications such as thickening, binding, emulsifying, stabilizing, and gelling agents.

Moreover, Mucilage exhibits unique rheological properties with considerable potential as a food thickener and stabilizer. Purwaningsih and Nuryanti (2020) mentioned that taro flour is utilized as a natural addition as a stabilizer in yoghurt products, so this research can be an innovation in the industrial world. These polymers such as natural gums and mucilage are biocompatible, cheap, and easily available and are preferred to semi-synthetic and synthetic excipients because of their lack of toxicity, low cost, availability, emollient, and non-irritant nature (Kulkani, *et al.,* (2005) and Malviya, *et al.,* (2011). Taro peels mucilage has a high carbohydrate content and small protein fraction, similar to commercial gums while commercial emulsifiers have a high content of lipids compared to taro mucilage. The emulsifying power of the studied mucilage is caused by the protein content along with weakly polar amino acids (Andrade *et al*., 2015).

Little previous studies used taro peels mucilage in the manufacture of low-fat soft white cheese, so, this work aimed to study the effect of adding a plant-derived waste product as taro peels mucilage to the manufacture of low-fat soft white cheese.

## 2. Materials and methods

### 2.1. Materials

Ingredients for cheese: buffalo milk, which came from the herd of Cairo University in Egypt's Faculty of Agriculture, was separated from fresh milk to create skim milk, which has 0.5 percent fat. The solvents used were bought from Sigma Company, USA; rennet powder (extra CHY-Max powder) was bought from Chr-Hansen's Lab in Denmark; and commercial sodium chloride was bought from El-Nasr Company for salt. All analytical grade chemicals used were supplied by El-Nasr Pharmaceutical Chemicals Co., Egypt. Taro was purchased at the adjacent market.

### 2.2. Methods

**Extraction of taro peels mucilage:**

Taro peels mucilage was extracted according to the method described by Arora *et al.* (2011) with some modifications. Fresh taro peels were washed with tap water and then it was shaped into small pieces. The shaped pieces were soaked in 1:5 (W/V) of distilled water. Heating at 50 ˚C for 2 h. Let to stand for half an hour followed by heating at 80 ˚C for 2h.

The extracted taro peels mucilage was filtered through muslin cloth to obtain mucilage. Three volumes of ethyl alcohol 95% were added to one volume of the supernatant to precipitate mucilage. The mixture was centrifuged (Hermal, Z 206 A) at 6000 rpm at room temperature for 10min. The mucilage was dried in an air-circulated oven at 40°C. The dried sample was ground to a fine powder in an electric grinder using a disc mill (Moulinex, made in France), sieved through 50 mesh, and stored at 5±2°C for further use.

**Preparation of cheese:**

Cheese making was carried out according to the traditional method described by Abou-Donia (2008), with some modifications regarding the addition of the taro peels mucilage to the cheese milk. Full-fat control cheese was made from fresh full-fat buffalos' milk (6.8 % F) as control (1) and skim milk was adjusted to milk fat (1% F) and divided into 4 equal portions: first is a control (2), different concentration of taro peels mucilage dry powder ranging from 0, 0.2, 0.4 and 0.6 % respectively were mixed with low milk fat ($T_1$, $T_2$, and$T_3$). Milk was left at 40 °C until complete coagulation. Then the curd was cut, packed in cheese cloth, and left for draining for one day at 4 °C. After that, the cheese was removed from the cheese cloth, cut into cubes, packed in plastic sheets then packed in a plastic container, and storage at 5±1ºC for 4 weeks and was analyzed at zero time, after 2, and 4 weeks

**Chemical, physical, and Functional characteristics of taro peels mucilage.**

The proximate composition, physical, and, Functional characteristics of taro peel mucilage and cheese were determined following the official method of analysis (AOAC, 2012).

**Chemical and physical characteristics of cheese.**

Cheese samples were tested for moisture, salt, and ash contents as mentioned in (AOAC, 2007). Total nitrogen and fat contents were determined according to IDF Standard 20A, and IDF Standard 5B (1986). pH values were measured using a digital laboratory Jenway 3510 pH meter, UK. Bibby Scientific LTD. Stone, Stafford Shire, ST 15 OSA.

**Total Phenolic Content of taro peels mucilage and cheese.**

Total phenolic compounds were determined based on a method described by Singleton *et al.* (1999), as reported by Mohamed *et al.* (2010). The results were expressed as mg (GAE) Gallic acid equivalent /g.

**Antioxidant activity of taro peels mucilage and cheese.**

The free radical scavenging activity of tested samples was measured according to the DPPH method as reported by Nanj *et al.* (1996).

**Water absorption of taro peels mucilage.**

Water absorption was carried out according to Chau and Cheung (1998). The taro peels mucilage was weighed (0.25 g), added with 25 ml distilled water, mixed with a magnetic stirrer for 15 min, and then centrifuged (K2015R, T10A, United Kingdom) at 3500 rpm for 30 min.

**Emulsion capacity (EC) of taro peels mucilage.**

The emulsion capacity of taro peels mucilage was determined as described by Obatol *et al,* (2001). The taro peel mucilage was weighed (1.0 g), dissolved in 50 ml distilled water, and added 50 ml refined oil (corn oil). Then, homogenizing for 1 min and centrifuged (K2015R, T10A, United Kingdom) at 1500 rpm for 5 min. Finally, the height of the emulsified layer was measured and compared with the height of the whole layer.

**Water holding capacity**

The water-holding capacity (WHC), reflecting the degree of syneresis, was also determined using the method developed by Ladjevardi *et al.* (2016). Cheese (10g) was weighed into a test tube and then centrifuged in a laboratory centrifuge at 5 ºC for 30 min at 5000 rpm. The precipitated whey was weighed. WHC was calculated based on the formula

$$\text{WHC (\%)} = (10 - W) / 10 \times 100\%$$

Where W—mass of the separated whey (g).

**Texture profile analysis.**

Texture measurement was performed and measured by a Universal testing machine (Cometech, B variety, Taiwan). According to Bourne (2002).

**Microbiological analysis:**

Total bacterial counts (TBC), yeasts and molds, and coliforms of tallga cheese were counted during the storage period at 5±1ºC at zero time, after 2, and 4 weeks according to Marshall (1992).

**Storage of prepared cheese**

The resultant cheese was stored in plastic bags in the refrigerator at 5±1ºC. All chemical and physical analyses were conducted at zero time, after two weeks, and four weeks.

**Sensory Evaluation**

Kebary *et al.* (2018) approach was employed to evaluate the soft cheese samples' sensory attributes [Appearance (15 degrees), Body and texture (35 degrees), Taste and Flavor (50 degrees), and Overall acceptability (100 degrees)]. By ten members from the Food Technology Research Institute, Agriculture Research Center, Giza, Egypt.

**Statistical Analysis**

According to Steel *et al.* (1997), the statistical analysis was performed using a one-way (split pilot) analysis of variance (ANOVA) under a significant level of 0.05 for the entire set of results using the statistical application CoStat (Ver. 6.400). LSD test was used to determine the significance between the means of various samples. Values are means of triplicate samples unless otherwise stated. The standard deviation (SD) was also calculated.

## 3. Results and Discussion

### 3.1. Proximate composition of taro peels mucilage.

Table (1) shows the values for the proximate composition of taro peel mucilage and the analyzed sample had a high protein content reached to 8.27%. The moisture content quantitatively differed from the other components. Even when the taro peels mucilage was oven-dried at low temperature, it had a moisture percentage (7.42%) that may have been acquired during storage, before analysis, and/or caused by incomplete drying. As for, crude fiber content and, total fat percentage the obtained results showed that they were lower than 1%, meanwhile, ash content was recorded at 3.44%. On the other hand, the total carbohydrate by difference was 80.20%. These obtained results may be due to the physiological stage of the rhizomes, and they agreed with Tavares *et al.* (2011), who reported that the moisture, ether extract, protein, and ash values of taro peels mucilage were 8.68, 0.70, 9.66, and, 5.33 g per 100 g, respectively, and Andrade *et al.* (2015) stated that protein content and the other component contents may be due to the maturation stage of the plant, which is one of the factors that decisively influences the characteristics of horticultural products. In taro rhizomes, the maximum dry matter content can be achieved for products that are close to physiological maturity, whereas the maximum protein content occurs well before the maturity stage.

### 3.2. Total phenolic content and antioxidant activity of taro peels mucilage

The mucilage of taro peels was analyzed to assess its total phenolic components and antioxidant activity. To determine whether the polysaccharide fractions may give a free radical hydrogen, the total phenolic components, and antioxidant activity were assessed. The total phenolic content in the mucilage of taro peels was found to be 29.52 mg/g as Gallic acid equivalent, as mentioned in Table (1). These findings are consistent with those of Nguimbou *et al.* (2012); Kim *et al*. 2019 and Hozifa *et al*. 2020, who reported that the total phenolic content in the mucilage of taro peels ranged from 28.0 to 35.4 mg ferulic acid equivalent/g 42.77, 32.32 and 32.20 mg/g as Gallic acid. Meanwhile, the antioxidant activity was 30.12% and this result agrees with (Kim, *et al*., 2019) who mentioned that anti-oxidant activity in steamed and un-steamed taro corm extracts by DPPH was recorded in 34.82 and 24.37% respectively. This activity may be due to the amount of phenolic compounds found in raw materials (Skyberg, *et al*., 2012).

### 3.3. Physical characteristics of taro peels mucilage.

Water absorption for taro peels mucilage has been shown in Table (1) which revealed that the value of taro peels mucilage (20.33 g water/g dry sample. These results were lower than the value of water absorption for taro peels mucilage powder which was 23.48g water/ g dry sample weight (Hozifa *et al.,* 2020), and who revealed that a high concentration of hydroxyl groups in polysaccharides had a high potential for water binding and was capable of absorbing significant amounts of water. The emulsion capacity value in mucilage extract taro peels mucilage was recorded at 24.18 %. From previous results, taro peels mucilage has high values in emulsion capacity. These results may be due to chemical composition especially the presence of carbohydrates (hydrophilic part) together with the small protein fraction, also its conformation, and the presence of amino acids with hydrophobic radicals. The lipid fraction may help in emulsification. Our results agree with Hozifa *et al*. (2020) who found that the emulsion capacity for taro mucilage powder was 28.57%.

**Table 1:** Proximate composition of taro peels mucilage and Functional characteristics (on D.W.B).

| **Chemical constituent %** | |
|---|---|
| Moisture% | 7.42±0.62 |
| Total fat % | 0.67±0.08 |
| Total protein % | 8.27±0.84 |
| Ash % | 3.44±0.20 |
| Crude fiber % | 0.41±0.05 |
| Total carb. % | 80.20±2.12 |
| **Total phenolic compounds and antioxidant activity** | |
| Total phenolic compounds (mg GAE/g) | 29.52 |
| Antioxidant activity % | 30.12 |
| **Physical characteristics** | |
| Emulsion capacity % | 24.18 |
| Water Absorption(g water/g) | 20.33 |

### 3.4. Chemical compositions of milk used for the manufacture of cheese:

Data present in Table (2) shows the chemical composition of milk used in the manufacture of cheese. The fat content of milk was standardized to be 1% fat for low-fat cheese milk which includes control (2), treatment (1), treatment (2), and treatment (3).

**Table 2:** Chemical compositions of milk used for the manufacture of low-fat white soft cheese.

| Treatments | Moisture (%) | Protein (%) | Fat (%) | Ash (%) | Carbohydrate (%) | pH |
|---|---|---|---|---|---|---|
| **Full-fat milk** | 84.1 | 3.4 | 6.8 | 0.8 | 4.9 | 6.58 |
| **Low-fat milk** | 89.6 | 3.6 | 1.0 | 0.8 | 5.0 | 6.57 |

### 3.5. Chemical compositions of low-fat white soft cheese

The chemical composition of soft cheese and its treatments using different levels of taro peel mucilage is presented in Table (3), the results indicated that there are significant differences between all different technological treatments and storage periods. From the obtained data it was noticed that with the increment of the percentage rate of the taro peel mucilage added to different treatments, the moisture, protein, and ash contents increased along the storage periods compared with the control

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**Table 3:** Chemical compositions of low-fat white soft cheese samples during storage period at 5± 1.0°C

| Treat. | Chemical constituents | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DM % | | | Protein % | | | F/DM % | | | Ash % | | | pH | | |
| | Zero time | After two weeks | After four weeks | Zero time | After two weeks | After four weeks | Zero time | After two weeks | After four weeks | Zero time | After two weeks | After four weeks | Zero time | After two weeks | After four weeks |
| **C1** | 39.39[a] ±0.79 | 38.97[a] ±0.94 | 38.73[a] ±0.48 | 15.22[c] ±0.73 | 15.57[c] ±0.52 | 15.42[c] ±0.30 | 45.88[a] ±0.83 | 46.38[a] ±0.60 | 47.21[a] ±0.44 | 3.47[d] ±0.28 | 3.60[cd] ±0.04 | 3.75[c] ±0.03 | 6.32[a] ±0.07 | 6.25[ab] ±0.02 | 6.25[ab] ±0.02 |
| **C2** | 32.75[b] ±0.28 | 31.98[bc] ±0.90 | 31.17[bd] ±0.79 | 17.59[a] ±0.35 | 17.81[a] ±0.15 | 17.83[a] ±0.17 | 21.39[b] ±0.93 | 21.46[b] ±0.97 | 22.08[b] ±0.88 | 3.77[c] ±0.02 | 3.81[c] ±0.05 | 3.82[c] ±0.06 | 6.23[ac] ±0.03 | 6.22[ac] ±0.04 | 6.21[ac] ±0.02 |
| **T1** | 30.47[ce] ±0.97 | 30.17[cf] ±1.04 | 29.97[cf] ±0.76 | 16.59[b] ±0.26 | 16.20 ±0.15 | 16.71[b] ±0.17 | 21.06[b] ±0.76 | 21.19[b] ±0.80 | 21.27[b] ±0.47 | 4.14[b] ±0.02 | 4.26[ab] ±0.05 | 4.28[ab] ±0.11 | 6.19[bc] ±0.04 | 6.16[bd] ±0.02 | 6.14[bd] ±0.09 |
| **T2** | 29.13[df] ±0.98 | 28.96[df] ±1.00 | 28.71[ef] ±0.96 | 16.28[b] ±0.14 | 16.34[b] ±0.17 | 16.39[b] ±0.22 | 20.63[b] ±0.86 | 20.83[b] ±0.43 | 20.83[b] ±0.32 | 4.32[ab] ±0.06 | 4.32[ab] ±0.12 | 4.33[ab] ±0.09 | 6.13[bd] ±0.01 | 6.12[bd] ±0.07 | 6.10[cd] ±0.10 |
| **T3** | 28.65[ef] ±1.01 | 28.09[ef] ±1.06 | 27.86[f] ±1.15 | 16.41[b] ±0.25 | 16.45[b] ±0.25 | 16.50[b] ±0.23 | 20.43[b] ±0.36 | 20.50[b] ±0.22 | 20.56[b] ±0.42 | 4.35[ab] ±0.09 | 4.36[ab] ±0.10 | 4.42[a] ±0.04 | 6.10[cd] ±0.02 | 6.04[d] ±0.02 | 5.93[e] ±0.01 |

*Values are means of triplicate samples. Means with different letters (a, b, c …) between columns indicate significant differences (P < 0.05). C1: Cheese control sample from full fat without adding mucilage, **C2**: Cheese control sample from low fat without adding mucilage, T**1**: Cheese treatments from low fat with added 0.2% mucilage, **T2**: Cheese treatments from low fat with added 0.4% mucilage, **T3**: Cheeses treatments from low fat with added 0.6%.

sample (1 and 2). On the other hand, the highest values of total solid were recorded in the cheese control (1) sample compared with cheese prepared from low milk fat with or without mucilage. It is clear from the obtained results that the addition of mucilage not only increases the moisture of treatments but also, reduces the loss of moisture of cheese up to the end of the storage period. This result may be due to the water-holding absorption of mucilage, (Shendi *et al*., 2010; Ali, *et al.,* (2016) and Hozifa, *et al*., 2020) revealed that a high concentration of hydroxyl groups in polysaccharides had a high potential for water-binding and was capable of absorbing significant amounts of water. Meanwhile, the pH values of the cheese control sample (1) were higher than control (2) and also the other treatments. It can be noticed that pH values were inversely related to the moisture content of the cheese. These results are similar to Katsiari *et al.* (2002) and Kavas *et al.* (2004). The changes in F/DM% as affected by reducing milk fat so that the highest value was recorded in the control cheese sample (1) sample compared with those cheese prepared from low milk fat with or without mucilage this agrees with Ali *et al.* (2016), Mistry (2001) who mentioned that fat and moisture act as filters in the casein network matrix of cheese so when reducing fat content, the moisture did not replace the fat on an equal basis**.**

### 3.5. Measurement of water holding capacity (WHC)

The ability of a material to bind with water in low water conditions is known as water holding capacity (WHC) (Singh, 2001). Table (4) shows how the mucilage from taro peels affects the water-holding capacity (WHC) of cheese samples. The mucilage from taro peels was shown to increase WHC in all treatments when compared to the cheese control without mucilage. This is because polysaccharides with high hydroxyl group concentrations have a high capacity for water binding and can absorb large amounts of water. Also, the cross-linking of milk proteins with mucilage leads to the stability of the protein network and a decrease in curd gel permeability which in turn prevents cheese whey expulsion. This is in line with those mentioned by Zayan, (2016) who used okra mucilage as a stabilizer in the production of functional Kareish cheese. Also, Lorenzen *et al.* (2002) mentioned that okra mucilage triggered the cross-linking of milk proteins leading to a stabilization of the three-dimensional network and a decrease in curd gel permeability which in turn prevents cheese whey expulsion. The ability of exopolysaccharides produced by cultures to produce cheese with high water holding capacity in Kareish cheese (Hassan *et al*., 2003). Also, Purwaningsih and Nuryanti (2020) mentioned that the addition of taro starch can increase the binding capacity of water. This occurs through electrostatic interactions with casein molecules so that there is inhibition of hydrophobic interactions in nonpolar molecules. At the end of the storage period, it was observed that WHC was decreased, and this may be due to the direct effect of acidity on WHC as ascertained by Fox *et al.,* (2000).

**Table 4:** Water holding capacity of cheese during storage period at 5± 1.0°C

| Water holding capacity % | | | | | |
|---|---|---|---|---|---|
| | Treatments | | | | |
| **Storage periods (weeks)** | **C1** | **C2** | **T1** | **T2** | **T3** |
| **Zero time** | $92.18^{e}$±0.84 | $94.91^{d}$±0.52 | $97.71^{c}$±0.64 | $99.78^{b}$±0.84 | $107.57^{a}$±1.11 |
| **After 4 weeks** | $81.80^{f}$±0.53 | $76.86^{h}$±0.56 | $79.68^{g}$±0.87 | $79.26^{g}$±1.25 | $80.74^{fg}$±0.68 |

*Values are means of triplicate samples. Means with different letters (a, b, c …) between columns indicate significant differences (P < 0.05). C1: Cheese control sample from full fat without adding mucilage, **C2**: Cheese control sample from low fat without adding mucilage, T**1**: Cheese treatments from low fat with added 0.2% mucilage, **T2**: Cheese treatments from low fat with added 0.4% mucilage, **T3**: Cheeses treatments from low fat with added 0.6%.

### 3.6. Total phenolic compounds antioxidant activity of cheese

Table (5) shows the total phenolic compounds and antioxidant activity of cheese. According to Unal (2012), control (1) showed higher antioxidant activity than control (2) because milk's antioxidant activity of milk increased since these compounds are found in the membranes of fat globules. Fat-soluble vitamins, mainly vitamin E, but especially α - tocopherol, also vitamin A and β- carotene, are the main antioxidants as mentioned by Stobiecka *et al.* (2022). As expected, values increased with the addition of mucilage which was considered a rich source of antioxidant compounds. As mentioned above it was in our study 30.12% which a agreeing with Kim *et al*. (2019) which was in turn reflected on values of treatment with mucilage. At the end of the storage period values increase as a result of increasing total solid. For total phenolic compounds the highest values were observed for treatment (3) with has the highest percentage of mucilage Purwaningsih and Nuryanti (2020) mentioned that taro tubers contain 2.65% flavonoids, 1.01% alkaloids, 0.70% saponins and 1.06% tannins. DPPH, ABTS, and ORAC analysis on the total contribution of polyphenols and flavonoids which was in turn reflected on values of treatment.

**Table 5:** Total phenolic compounds and Antioxidant activity of cheese during storage period at 5± 1.0°C

| **Total phenolic compounds (mg/g)** | | | | | |
|---|---|---|---|---|---|
| | **Treatments** | | | | |
| **Storage periods (weeks)** | **C1** | **C2** | **T1** | **T2** | **T3** |
| **Zero time** | 0.15$^{e}$±0.02 | 0.20$^{e}$±0.02 | 0.25$^{e}$±0.01 | 0.48$^{d}$±0.04 | 0.86$^{b}$±0.06 |
| **After 4 weeks** | 0.13$^{e}$±0.01 | 0.23$^{e}$±0.01 | 0.59$^{c}$±0.03 | 0.61$^{c}$±0.05 | 1.27$^{a}$±0.12 |
| **Antioxidant activity%** | | | | | |
| | **Treatments** | | | | |
| **Storage periods (weeks)** | **C1** | **C2** | **T1** | **T2** | **T3** |
| **Zero time** | 3.61$^{g}$±0.35 | 3.37$^{g}$ ±0.35 | 22.96$^{e}$ ±0.50 | 33.53$^{d}$±1.53 | 52.94$^{b}$±0.50 |
| **After 4 weeks** | 6.35$^{f}$±0.25 | 4.68$^{g}$±0.36 | 39.39$^{c}$±1.00 | 53.70$^{b}$±0.67 | 58.10$^{a}$±0.53 |

**Values are means of triplicate samples. Means with different letters (a, b, c …) between columns indicate significant differences (P < 0.05). C1: Cheese control sample from full fat without adding mucilage, **C2**: Cheese control sample from low fat without adding mucilage, T**1**: Cheese treatments from low fat with added 0.2% mucilage, **T2**: Cheese treatments from low fat with added 0.4% mucilage, **T3**: Cheeses treatments from low fat with added 0.6%.

### 3.7. Textural properties

In addition to being a highly helpful approach for researching food goods, texture features are a key attribute of products that contribute to determining the quality and acceptance of this product. Double compression tests were used in this study to evaluate the TPA (texture profile analysis) characteristics of a low-fat white soft cheese. The results are displayed in Table (6). The outcomes showed that there are notable variations across all the various technical treatments and storage periods. It was evident that decreasing milk fat enhanced the hardness of the cheese, as evidenced by the fact that control (2) had a harder hardness value (1.5 N) than control (1), which had a bit less hardness value (0.8 N). On the contrary, the addition of mucilage decreases the hardness. The hardness values of treatment cheese were 0.7, 0.9, and 1.3 N for T3, T2, and T1 respectively. This result agrees with those obtained by Beal and Mittal (2000) who reported that increased moisture content infirmities the protein system creating less firm cheese (Zayan, 2016 and Enas *et al*., 2022). Moreover, Hardness increased the storage period. Cohesiveness values had the same trend as hardness which recorded a high value for control (2) and decreased with the addition of mucilage this agrees with El-Zeini *et al.* (2007). Springiness is the ability of cheese to go back to its original shape after the force is removed. Adding mucilage causes an increase in the springiness values. Moreover, decreases during the storage period, and results agree with that got by Zisu and Shah (2005). Each gumminess and chewiness had the same trend, the addition of mucilage led to a decrease in values of fresh which also decreased during the storage period. This may be due to the proteolysis activity. These results agree with those reported by El-Mahdy, (2011); Kheder (2016) and Zayan, (2016).

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**Table 6:** Texture profile analysis of Cheese during storage at 5±1ºC

| Treat. | Texture profile | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Hardness | | | Cohesiveness | | | Springiness | | | Gumminess | | | Chewiness | | |
| | Zero time | After two weeks | After four weeks | Zero time | After two weeks | After four weeks | Zero time | After two weeks | After four weeks | Zero time | After two weeks | After four weeks | Zero time | After two weeks | After four weeks |
| **C1** | $4.65^{a}$ ±0.10 | $4.30^{b}$ ±0.12 | $3.47^{c}$ ±0.26 | $0.88^{a}$ ±0.10 | $0.85^{ab}$ ±0.11 | $0.82^{ab}$ ±0.02 | $3.50^{a}$ ±0.61 | $3.32^{a}$ ±0.02 | $3.32^{a}$ ±0.11 | $3.40^{a}$ ±0.10 | $3.30^{a}$ ±0.20 | $3.10^{a}$ ±0.10 | $6.01^{a}$ ±0.08 | $3.72^{b}$ ±0.10 | $3.66^{b}$ ±0.02 |
| **C2** | $2.53^{d}$ ±0.21 | $2.40^{d}$ ±0.10 | $1.67^{e}$ ±0.28 | $0.82^{ab}$ ±0.01 | $0.80^{ab}$ ±0.01 | $0.80^{ab}$ ±0.02 | $2.88^{b}$ ±0.01 | $2.85^{bc}$ ±0.03 | $2.79^{bd}$ ±0.03 | $2.76^{b}$ ±0.10 | $1.37^{c}$ ±0.12 | $1.26^{c}$ ±0.12 | $3.25^{bc}$ ±0.09 | $3.18^{bc}$ ±0.05 | $2.95^{cd}$ ±0.10 |
| **T1** | $1.57^{e}$ ±0.23 | $1.50^{e}$ ±0.10 | $1.43^{ef}$ ±0.05 | $0.79^{ab}$ ±0.10 | $0.77^{ab}$ ±0.02 | $0.76^{ab}$ ±0.01 | $2.61^{be}$ ±0.20 | $2.60^{be}$ ±0.05 | $2.48^{cf}$ ±0.01 | $1.26^{c}$ ±0.10 | $1.20^{c}$ ±0.12 | $0.90^{d}$ ±0.10 | $2.90^{cd}$ ±0.01 | $2.76^{ce}$ ±0.10 | $2.41^{de}$ ±0.02 |
| **T2** | $1.30^{eg}$ ±0.15 | $1.30^{eg}$ ±0.17 | $1.07^{fh}$ ±0.15 | $0.75^{ab}$ ±0.01 | $0.74^{ab}$ ±0.02 | $0.74^{ab}$ ±0.02 | $2.41^{df}$ ±0.01 | $240^{df}$ ±0.02 | $2.39^{df}$ ±0.01 | $0.80^{de}$ ±0.20 | $0.80^{de}$ ±0.10 | $0.70^{df}$ ±0.20 | $2.38^{de}$ ±0.42 | $2.19^{ef}$ ±0.01 | $2.08^{ef}$ ±0.02 |
| **T3** | $0.93^{gh}$ ±0.10 | $0.80^{h}$ ±0.12 | $0.70^{h}$ ±0.20 | $0.73^{ab}$ ±0.02 | $0.72^{ab}$ ±0.13 | $0.68^{b}$ ±0.01 | $2.29^{ef}$ ±0.15 | $2.17^{f}$ ±0.06 | $2.11^{f}$ ±0.03 | $0.50^{ef}$ ±0.10 | $0.50^{ef}$ ±0.10 | $0.40^{f}$ ±0.10 | $1.64^{fg}$ ±0.06 | $1.62^{fg}$ ±0.10 | $1.23^{g}$ ±0.09 |

*Values are means of triplicate samples. Means with different letters (a, b, c …) between columns indicate significant differences ($P < 0.05$). **C1:** Cheese control sample from full fat without adding mucilage, **C2**: Cheese control sample from low fat without adding mucilage, T**1**: Cheese treatments from low fat with added 0.2% mucilage, **T2**: Cheese treatments from low fat with added 0.4% mucilage, **T3**: Cheeses treatments from low fat with added 0.6%.

**3.8. Microbiological analysis of low-fat white cheese: -**

The total bacteria count (TBC) is the most used and dependable tool for evaluating the hygienic status of food and food additives. Data presented in Table (7) displayed the total bacterial counts (TBC) of cheese. The results showed that control (2) had higher TBC than control (1) this might be the increase in moisture content, as well as the TBC higher in the treatment which was treated with mucilage, this result agrees with Setiarto *et al*. (2022) who mentioned that Taro flour can be added to yogurt as a prebiotic to stimulate the growth of probiotic bacteria. Molds and yeasts do appear to dominate the microflora of the samples of powder samples. At the end of the storage period, the (TBC) decreased in control cheese than in cheese treated with mucilage, this might be due to the consumption of milk nutrients during the storage period as reported by Akl *et al*. (2020). Also, it might be the decrease in the pH value of cheese during storage has a negative effect on bacteria (Mehri *et al*., 2013). Molds and yeasts counts were not detected at zero time also, at the second storage period after two weeks in all treatments, meanwhile, it was increased during the last storage period. These results agreed with the results reported by Nayra *et al*. (2002) who mentioned that the mold and yeast of soft cheese started to appear after 15 days of storage period. No colonies of coliform bacteria were detected in all treatments neither at zero time nor at the second and last storage periods in all treatments. The samples were all in compliance with the microbial limits of NFSA Decree, (2021).

**Table 7:** Microbiological analysis of low-fat white cheese during storage at 5±1°C

| Microbiological analysis | Storage periods (Weeks) | Treatments | | | | |
|---|---|---|---|---|---|---|
| | | **C1** | **C2** | **T1** | **T2** | **T3** |
| **Total bacterial count (log cfu /g)** | Fresh | 4.6 | 5.1 | 5.3 | 5.4 | 6.2 |
| | 2 | 4.7 | 5.2 | 5.5 | 5.6 | 6.3 |
| | 4 | 3.8 | 5.1 | 5.1 | 5.3 | 6.0 |
| **Moulds and Yeasts counts (log cfu /g)** | Fresh | ND | ND | ND | ND | ND |
| | 2 | ND | ND | ND | ND | ND |
| | 4 | 1.0 | 1.6 | 1.6 | 1.7 | 1.8 |

*Values are means of triplicate samples. Means with different letters (a, b, c …) between columns indicate significant differences (P < 0.05). C1: Cheese control sample from full fat without adding mucilage, **C2**: Cheese control sample from low fat without adding mucilage, T**1**: Cheese treatments from low fat with added 0.2% mucilage, **T2**: Cheese treatments from low fat with added 0.4% mucilage, **T3**: Cheeses treatments from low fat with added 0.6%.

**3.9. Sensory attributes of low-fat white soft cheese with taro peels mucilage peels.**

Sensory evaluation is one of the most important tests in the evaluation of food products which reflects in turn on its overall acceptability and the extent to which the consumer benefits from it. The scores for sensory evaluation in terms of appearance, body and texture, taste and flavor, and overall acceptability were tested and the results were statistically analyzed and illustrated in Table (8). The effect of each adding mucilage taro peels, storage periods on sensory characteristics, and overall acceptability of the resulting cheese were studied. These findings displayed that the high sensory evaluation degrees for appearance, body, and texture as well as the overall acceptability, were recorded (C1) because the reduction in fat content affected the appearance, body and texture, taste and flavor, and overall acceptability followed by T2 (0.4%) this agrees with (Zayan, 2016) who stated that Kareish cheeses made with different levels of okra mucilage had got the highest scores in body and texture which could be attributed to WHC and EC properties of mucilage.

Additionally, full-fat cheese had a higher sensory parameter than low-fat cheese and contained hydrocolloids; nevertheless, adding hydrocolloids to low-fat cheese enhances its overall acceptability (Ali *et al*., 2016). Regarding the Impact of mucilage addition and storage periods on the aforementioned sensory attributes, the findings showed that there are significant variations across all treatments and durations of storage. As for, taste and flavor, (C1), T2(0.4%), and T1 (0.2%) reported the greatest levels, followed by T3 (0.6%). These results may be due to the addition of different ratio of mucilage which led to the rich and creamy taste. The obtained data showed that during the storage period, all the tested sensory attributes were decreased but, in the same trend. As for, the interaction effects of the previous factors, it appeared through the obtained results that there are significant differences between the values

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**Table 8:** Sensory attributes of low-fat white soft cheese with taro peels mucilage peels during storage at 5±1°C.

| Treat. | Sensory attributes | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Appearance | | | Body and texture | | | Taste and Flavor | | | Overall acceptability | | |
| | Zero time | After two weeks | After four weeks | Zero time | After two weeks | After four weeks | Zero time | After Two weeks | After four weeks | Zero time | After two weeks | After four weeks |
| C1 | 14.28[a] ±0.87 | 14.18[ab] ±0.76 | 13.84[ab] ±0.70 | 48.70[a] ±1.28 | 48.52[a] ±0.65 | 48.07[ab] ±0.67 | 34.73[a] ±0.27 | 34.71[a] ±0.44 | 34.64[a] ±0.28 | 97.94[a] ±1.20 | 97.42[a] ±0.76 | 95.95[b] ±0.53 |
| C2 | 12.59[ab] ±0.47 | 12.28[b] ±0.38 | 12.27[b] ±0.08 | 42.17[e] ±0.22 | 39.93[f] ±1.17 | 33.26[g] ±0.75 | 30.36[b] ±0.55 | 29.23[c] ±0.69 | 29.03[c] ±0.64 | 85.78[g] ±0.43 | 82.69[h] ±0.40 | 74.99[i] ±1.01 |
| T1 | 13.26[ab] ±0.70 | 13.25[ab] ±0.30 | 13.04[ab] ±0.31 | 46.24[cd] ±1.47 | 46.10c[d] ±0.83 | 45.18[d] ±1.30 | 33.80[a] ±0.76 | 33.60[a] ±0.70 | 33.31[a] ±0.56 | 93.91[cd] ±0.71 | 92.85[de] ±0.36 | 92.57[de] ±0.63 |
| T2 | 13.78[ab] ±0.30 | 13.72[ab] ±0.32 | 13.70[ab] ±0.54 | 47.06[bc] ±1.03 | 46.98[bc] ±1.39 | 46.30[cd] ±0.73 | 34.23[a] ±0.77 | 34.22[a] ±0.28 | 34.18[a] ±0.30 | 94.76[bc] ±0.73 | 94.73[bc] ±0.56 | 94.35[c] ±0.79 |
| T3 | 12.86[ab] ±0.25 | 12.70[ab] ±0.35 | 12.64[ab] ±0.68 | 44.99[d] ±0.46 | 44.72[d] ±1.20 | 44.72[d] ±1.37 | 33.12[a] ±0.44 | 32.91[a] ±0.91 | 31.15[b] ±0.33 | 92.04[e] ±0.77 | 89.04[f] ±0.56 | 88.92[f] ±0.50 |

*Values are means of triplicate samples. Means with different letters (a, b, c …) between columns indicate significant differences (P < 0.05). **C1:** Cheese control sample from full fat without adding mucilage, **C2**: Cheese control sample from low fat without adding mucilage, T**1**: Cheese treatments from low fat with added 0.2% mucilage, **T2**: Cheese treatments from low fat with added 0.4% mucilage, **T3**: Cheeses treatments from low fat with added 0.6%.

of sensory attributes for all treatments, and T2 (0.4%) recorded the highest values for the degree of overall acceptability, which indicates that T2 (0.4%) is the most desired one.

## 4. Conclusion

From the previously obtained results, we can conclude that mucilage can improve the functional and organoleptic properties of low-fat white soft cheese as well as enhance the nutritional content. Also, the addition can offer cost-saving opportunities.

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