

## Investigation of Physicochemical and Sensory Properties of Processed Cheese Sold in Western Costal Region, Libya

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### دراسة بعض الخصائص الفيزيائية والكيميائية والحسية للجبن المصنوع المباع في المنطقة الساحلية الغربية، ليبيا

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Received: October 11, 2025 | Accepted: December 20, 2025 | Published: December 29, 2025

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#### Abstract:

Present study was aimed to evaluate the sensory and physicochemical properties of processed cheese (PC) available in the markets. A total of 50 samples including different PC imported and domestic brands were collected from shops in Western costal region of Libya, during the period June-August 2024. The samples were subjected to sensory evaluation and physicochemical analysis. Based on Libyan and international standards, the cheese samples were at standard limits on all chemical composition under study (fat, protein, moisture, ash, pH). Results showed that fat percentage, total protein and ash content, and pH of PC samples were not significantly affected by the time of the samples collection, while the moisture content was higher in samples of domestic PC. There is a statistically significant difference between local and imported samples ( $P > 0.05$ ) in the average fat percentage (21.71% in local samples and 25.5% in imported sample) and moisture content (40.57% in local sample and 35.2% in imported sample). Other physicochemical characteristics did not reveal statistically differences. In general conclusion, the samples were at acceptable level and can be considered as safe products in terms of tested criteria. However, some defects were found which were related to improper storage, handling and vending of the products without complying with guidelines and regulations. Further investigation might be required to ensure the food safety following the food handling regulations and guidelines.

**Keywords:** Processed cheeses, Natural cheese, Chemical analyses, Sensory evaluation, Physicochemical properties of cheese.

#### الملخص:

هدفت هذه الدراسة إلى تقييم الخصائص الحسية والفيزيائية والكيميائية للجبن المصنوع المباع في الأسواق. حيث جمعت 50 عينة، شملت مختلف الأنواع المستوردة والمحلية، من متاجر في المنطقة الساحلية الغربية بليبيا، خلال الفترة من يونيو إلى أغسطس 2024. خضعت العينات للتقييم الحسي والتحليل الفيزيائي والكيميائي. وذلك استناداً إلى المعايير الليبية والدولية، حيث كانت عينات الجبن مطابقة للمواصفات القياسية لجميع المكونات الكيميائية قيد الدراسة (الدهون، البروتين، الرطوبة،

الرماد، الرقم الهيدروجيني). وأظهرت النتائج أن نسبة الدهون، ومحتوى البروتين الكلي والرماد، الرقم الهيدروجيني في عينات الجبن لم تتأثر بشكل ملحوظ بوقت جمع العينات، بينما كان محتوى الرطوبة أعلى في عينات الجبن المحلي. حيث يوجد فرق ذو دلالة إحصائية بين العينات المحلية والمستوردة في متوسط نسبة الدهون (21.71% في العينات المحلية و25.5% في العينات المستوردة) ومحتوى الرطوبة (40.57% في العينات المحلية و35.2% في العينات المستوردة). ولم تُظهر الخصائص الفيزيائية والكيميائية الأخرى أي فروق ذات دلائل إحصائية. بشكل عام، كانت العينات عند مستوى مقبول، ويمكن اعتبارها منتجات آمنة وفقاً للمعايير المختبرة في هذه الدراسة. ومع ذلك، وُجدت بعض العيوب المتعلقة بالتخزين والتداول والبيع غير السليم للمنتجات دون الامتثال للإرشادات واللوائح. وقد يلزم إجراء المزيد من الدراسات لمعرفة مدى التزام موزعي منتجات الأغذية باللوائح والإرشادات الخاصة بتناول ونقل وبيع الأغذية.

**الكلمات المفتاحية:** الجبن المصنوع، الجبن الطبيعي، التحاليل الكيميائية، التقييم الحسي، الخصائص الفيزيائية والكيميائية للجبن.

### **Introduction:**

Processed cheeses (PC) are byproducts of natural cheeses (NC), that are made by blend of different types of shredded NC with emulsifying agents and mixed with other ingredients such as salts, vegetable oil, preservatives and food colouring. The mixture is then agitated and heated under a constant partial vacuum until homogenous mass of cheese is obtained (McSweeney, P. L., Ottogalli, G., & Fox, P. F. 2017). Consequently, many flavours, colours and textures of PC exist. Typically, PC contains around 50–60% NC and 40–50% other ingredients which include both dairy and non-dairy origin additives (Cariae & Kalab, 1987; Chambere & Daurelles, 2000). Production of PC has several advantages including low-cost production, shelf-life prolongation and staple physiochemical properties under retailer, handling, cooking and consumption conditions. For example, using second grade NC to produce PC can overcome NC mechanical defects. Furthermore, saving time and cost of PC production by using premature NC to produce PC. Thus, it is preferably produced over other types of cheese by cheesemakers. Advantages of PC over NC has impact on PC consumption which has been constantly increased since it was first developed by Fritz Stettler and Walter Gerber in 1911, Switzerland (Gouda, A., and Abou El-nour, A., 2003; Market.us, 2025). In dairy market, PC is preferable by cheese consumers than NC due to advantages of PC over NC as PC can be stored without refrigeration, produced in different shapes, flavours, and physical properties; soft, firm, spreadable. Moreover, PC is available in variable and attractive packages, and it has a relatively long shelf-life and mostly considered pathogens free (El Dakhakhny, E., and Dabour, N. 2016). Different brands of PC are sold in Libyan markets. In 2023, Libya imported a value of 172 Million dollars' worth of cheese, ranks the 43<sup>rd</sup> largest cheese importer (out of 225) in the world (The observatory of economic complexity, 2023).

Due to high nutritional value and flavour of PC, it has been used in various applications, including ready-to-eat meals, snacks sauces, cooking and baking different dishes like pizza (Walther, B. et.al., 2008). The physicochemical properties of cheese, such as moisture content, fat percent, pH, salt content, and protein composition have significant impact on cheeses quality, including texture, flavour, and shelf life. Which further impacts consumer acceptance of the products. Because of high nutritional contents of cheese, it is perishable and may be subjected to adulteration. Extra care should be taken to avoid delivering bad quality cheese that is unfit for human consumption and poses health risk to consumers (Thomareis, A. S., & Chatziantoniou, S. E. 2022). Cheese quality is a significant concern for social, economic, and health reasons. Therefore, physio-chemical and organoleptic analysis might be performed to assess the cheese's quality for human consumption. In consumer point of view, consumption of PC must meet standard requirements, for example health safety and organoleptic characteristics of PC which reflect physiochemical quality of the product (Mihafu, D., et. al., 2020). Changes in these properties during cheese making, ripening storage and marketing can affect the cheese's microstructure and sensory characteristics. There for, this study was aimed to investigate the chemical, physical and sensory properties of PC sold in Libyan markets and evaluated under retailer conditions for chemical and physical properties according to Libyan and international standards.

### **Materials and methods:**

#### **Sampling and sample collection:**

A total of 50 PC samples (25 local PC and 25 imported PC samples) were collected from the supermarkets of different cities in the Western costal region of Libya. Cheese samples include local made and imported brands that comprised different companies. The samples were collected during the period from June to August 2024. The collected samples were transported in an insulated icebox without delay to the laboratory of National Medical Research Centre Alzawia and The Libyan Food and Drug Control Centre Zwara. During the analysis, the PC samples were subjected to Physiochemical analysis in addition to organoleptic evaluation.

### Organoleptic evaluation:

Before physicochemical analysis, the collected samples were encoded and subjected to organoleptic evaluation by 5 sensory panellists whom familiar with cheese characteristics. Prior of the evaluation, panellists were demonstrated about using questionnaire forms and verbal consents were obtained from them, agreeing to evaluate the cheeses. Ethically, the study does not pose human health risk as the evaluated products were cheese products which were sold in the groceries and ready to use by public ordinary consumers and the volunteers were cheese lover who don't have any allergy to dairy products. The coded samples were served to each member of panellists in a quiet place at room temperature. Panellist members were requested to evaluate each sample separately without comparing between samples.

Using a five-points Hedonic scale to score samples for flavour, aroma (odour and taste), colour, body, and texture, and overall packaging and acceptability according to Kumar, S. *et al.* 2014, with some modification by adding visual evaluation of cheese packaging and overall acceptability (Table 1).

**Table (1):** Assessment of the organoleptic properties of the cheese using five-points hedonic scale.

Hedonic Scale	1	2	3	4	5
Flavour; aroma (Taste and Odour)					
Colour					
Body					
Texture					
Packaging condition and general appearance					

Sensory appeal of PC samples was evaluated based on five points hedonic test which ranged from 5 to 1; where 5, 4, 3, 2 and 1 means highly liked, moderately liked, neither liked nor disliked, moderately disliked, and highly disliked, respectively (Larmond E., 1991). The samples were divided into groups and tested 5 samples per seat until all samples were evaluated. Sensory evaluation was carried out in a well lightened room. Each evaluator sat in a separate place for around 30 min to evaluate each of the 5 samples. Pieces of bread and water were used to neutralize the taste between samples.

### Physicochemical analysis:

The total fat percent was determined by Gerber method described by Association of Official Analytical Collaboration (AOAC) (AOAC, 1990). Protein percentage was determined by Kjeldahl method according to method described by AOAC (AOAC, 2000). Moisture content was determined by gravimetric method (AOAC, 2000). Ash was determined according to the method of AOAC (AOAC, 2000). Previously calibrated pH meter was used to determine pH of samples by insertion of pH electrode into the soft PC samples. For semi-hard and hard PC, a small amount of water was added to get proper contact between the sample and pH probe (Ardö and Polychroniadou, 1999).

Calculation method was used to estimate total carbohydrate amounts. After determination of the percentages of moisture, ash, protein and fat of cheese sample. The total percentage then subtracted from 100 % according to Cebec, A (Cebeci, A., *et al.*, 2020).

All figures of chemical constituents of the PC samples were presented as a percent per 100 grams of PC samples.

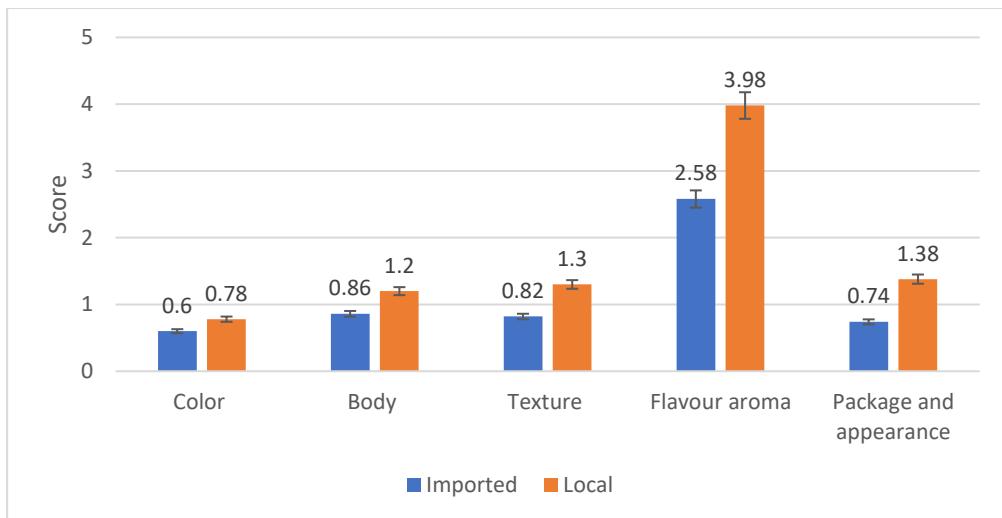
### Statistical analysis:

Statistical analysis was conducted by using the one-way Analysis of Variance (ANOVA, Microsoft Excel, Version 2019). The ANOVA used to determine whether there were any significant mean differences in the characteristics of PC samples.  $P < 0.05$  considered statically significant difference.

### Results and discussion:

Cheese is a dairy product which mainly consists of water, fat, carbohydrate, protein and other minor constituents such as minerals and organic compounds which contribute to its nutritional value, flavour and texture. The components of cheeses are varying depending on the type of cheese and its processing method (Lamichhane, P., *et al.*, 2018). As PC is produced by blending mixture of NC with other ingredients. Thus, PC consists of basic of NC components in addition to other dairy and non-dairy food ingredients which are added during PC manufacture. This reflects compositional variety among cheese types. Thus, food regulations establish specific standards of identity for different cheese types and set mandatory limits on main constituents such as minimum fat content and maximum moisture content. These limits reflect the natural variation in compositions among cheeses while ensuring product consistency and proper labelling for consumers (Koca, N., *et al.*, 2022).

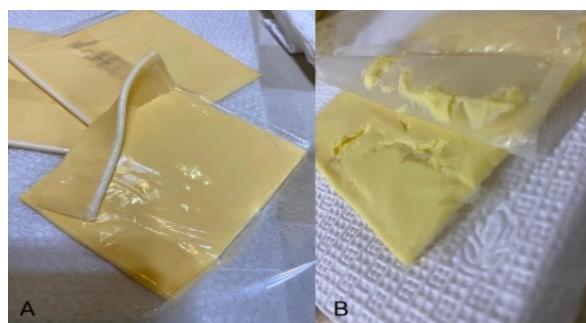
In this study, the quality of PC samples was mainly evaluated by physicochemical properties and sensory attributes, nutritional properties and level customers acceptability of cheeses.



**Figure (1):** The sensory evaluation the samples.

Many of these functionalities are determined by cheese constituents, structure and requiring an appropriate understanding of the relationships between cheese characteristics and constituents. Organoleptic evaluation of PC samples was presented in (Figure 1) which shows the sensory evaluation of the PC samples including 5 characteristics. The sensory evaluation of the samples indicate that imported samples were significantly scored higher than local cheeses in terms of flavour and aroma, and package and appearance characteristics ( $P < 0.05$ ). This reflects fat and water content as flavour (taste and odour) is mainly affected by chemical composition e.g. fat content (Yoo, J., & Lee, W. J. 2024). The results indicate that no significant difference in the other sensory attributes between the domestic and the imported PC samples and generally all samples revealed acceptable level according to panellist members. However, the stickiness of cheese body to its foil packaging reduces the PC quality. This was more obvious in local samples than imported samples, the defect affects simplicity peeling of packaging a foil wrapper due to stickiness of cheeses to the wrapper (McSweeney, P., 2007). The difficulty of unwrapping individual PC portions is a widely recognized consumer complaint that stems from the specific properties of the product and its packaging requirements (Wilson, C. 2012). In this study, difficulties of the unwrapping of cheeses (Figure 2) may be due to improper storage conditions such as high temperature (above 25° C) which had been noticed during samples collection from some shops.

Some of the cheese samples show edge white discoloration which may be due to damaged package, improper storage (exposure to the light and oxygen) or microbial contamination. However, it may be considered safe if it is not due to microbial contamination, it would affect sensory appeal of the product (Juric, M., et. al., 2003).



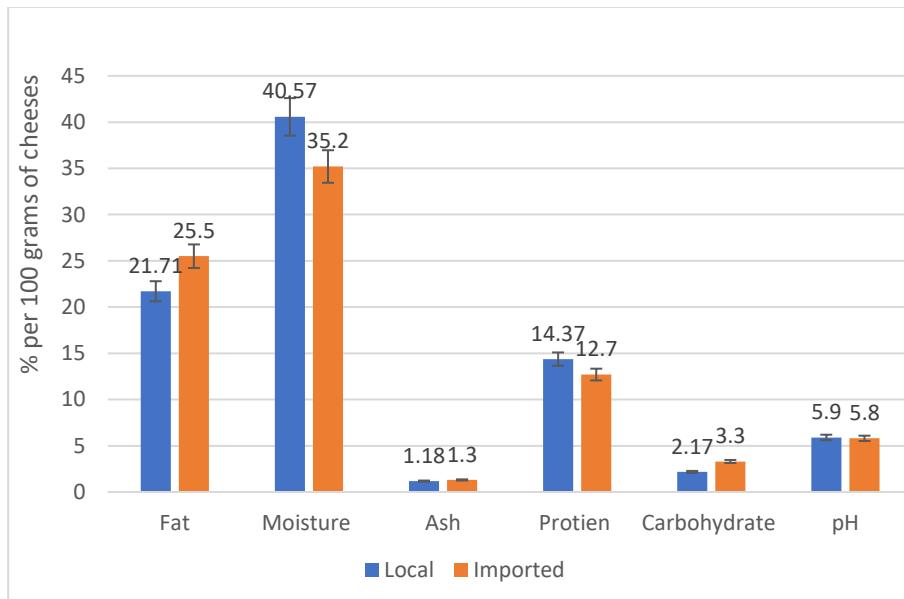
**Figure (2):** Color defect (A) and texture defect (B).

Chemical analysis of local cheeses samples shows slightly higher in moisture and fat (Figure 3). High fat and water contents in addition to improper storage of cheeses might result in difficulties in peeling of the cheeses as water and fat content compromise the cheese's structural integrity and microbial stability, causing a softer texture that is hard to separate from the cheeses wrapper. While high fat can reduce rigidity and high water can decrease firmness. Moreover, improper storage promotes enzymatic and microbial activity, further softening the cheese and potentially leading to degradation, making it challenging to peel properly (Lu, M., & Wang, N. S. 2017).

In general, according to Libyan national centre for standardization and metrology (LNCSM), and international standards such as the Codex Alimentarius for cheeses standards, water content in PC varied based on cheeses type and it ranges between 40% to 60%. The casein matrix entrapping fat globules and bounded to water which are important contributors to cheese texture that affects spreading or slicing features of the cheese (Malcata, F., & Kongo, J. 2016).

High water content affects the water activity ( $a_w$ ) which is important for microbial and enzymatic activity of the product which affects microbial quality and organoleptic characteristics of the PC. In our study, the chemical analysis of tested samples revealed that water content percentage was higher in local cheeses comparing to imported. This might contribute of softening PC texture causing peeling struggle (Lee, S. K., et. al., 2015).

There is an interaction between pH and dairy product constituents such as fat protein and moisture content, as any changes in the pH value, which will lead to an increase in the moisture in the product, by increasing the absorption of protein molecules to water. Thus, the appropriate pH value is crucial for cheese textural, controlling the growth of bacteria, ensuring the safety of the cheese, and improving the quality of the cheese (Aydogdu, T. et. al., 2023). In general, acceptable pH of PC is ranged from 5.7 and 5.9. The pH of the collected PC samples ranged from 5.43 and 5.92 which is within the normal range for PC. Deviation of these figures may promote microbial growth and increase health risk as higher pH is favourable for pathogenic and food spoilage microorganisms (Buňková, L., & Buňka, F. 2017).



**Figure (3):** Chemical analysis, percent per 100 g. and pH of cheese samples. Measurement of pH is based on pH scale from 0 to 14.

In our study, protein content was averaged 14.37 % and 12.7 % of imported and local cheese respectively without a significant deference between both imported and local cheeses (Figure 3). Protein in NC is normally high and based on cheeses type; it is higher in hard cheese (Walther, B., et.al., 2008). In PC the milk protein content is lower in PC than NC as PC contains 40% to 60 % of NC (Cariae & Kalab, 1987; Chambere & Daurelles, 2000). In literature, it has been reported similar result for PC indicating that PC normally lower comparing to NC (Dobson, S., & Marangoni, A., 2023). The main carbohydrate in dairy products is lactose. In cheese, lactose is very low because it is fermented by lactic acid bacteria into lactic acid, but a trace amount may remain, also some cheeses may have added sugars or other carbohydrate-containing ingredients so determination of lactose in cheese is crucial for those suffer from lactose intolerance (Cebeci, A., et. al., 2020). The result showed that low amount of carbohydrate which is likely from non-lactose ingredients source from ingredients added during PC manufacturing (El-Bakry, M., & Mehta, B. 2022).

#### Conclusion:

The results illustrate that overall evaluation of cheese samples were acceptable. However, some defects were found which related to improper storage, handling, display and vending of the products without comply with standards and regulations. The improper conditions of PC handling, storage and vending lead to alteration of physicochemical proprieties causing softening of cheese texture then leads to difficult of peeling. The changes of physicochemical properties could lead to unwanted activity of some enzymes also improper condition impacts significantly on microbial quality of cheese. Enzymatic

activity and microbial growth will break down main components of cheeses such as fatty acids which subsequently affect the products keeping quality. So, it is highly recommended for distributors and grocers to properly handle the products according to guidelines and regulations of manufacturers, authority and food standard agencies. Therefore, the products were safe for human consumption based on investigated properties provided its storage and handling are done appropriately. Further investigation including microbial testing may require ensuring the PC products are chemically, physically and microbially safe.

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