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# The Effect of Water Replacement with Different Proportions of Permeate on the Properties and Quality of Processed Cheese

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## ABSTRACT

In this research, the effect of replacing water used in the manufacture of processed cheese with different percentages of permeate on the properties cheese. The results were as follows: an increase in the total solids of the cheese was observed with the increase in the percentage was (49.73%). Also, an increase in both protein and fat (8.82-19.64%) with the increase in the percentage of replacement was observed. Also, the percentage of fat in the solid material decreased (40.35%). An increase in the pH values (5.31) was observed with the increase in the percentage of replacement and a decrease with storage. The same reverse effect was observed for acidity in all samples. Regarding microbiological properties and bacterial count, it was observed that with increasing the addition percentage, the total microbial count increased. The lowest numbers were in the control sample, which was 2 x $10^3$, while the numbers increased with storage, reaching 11 x $10^3$ at the end of storage. There was also a non-noticeable increase in the numbers of fungi and yeasts with increasing the replacement percentage, during the storage period. The lowest numbers were in the control sample, whether in fresh cheese or after 90 days (1-9 x $10^3$), while chloroform and staphylococcus bacteria were not present, whether in fresh cheese or at the end of storage. Regarding rheological properties, the hardness increased, and the rest of the rheological decreased with increasing the replacement percentage. The sensory properties of the cheese, whether, were better with increasing the replacement.

***Keywords:*** processed cheese , permeate ,properties ,effect

## INTRODUCTION

There are numerous definitions describing processed cheese. In additions, rocessed cheese continues to gain appeal because of its broad composition and wide applications (El Dakhakhny and Dabour, 2016). Among them, the definition proposed by (Guinee *et al*., 2004) is the most frequently used and the simplest one.

The processed cheese as "the cheese which can be produced by blending natural cheese of different ages and degrees of maturity in the presence of emulsifying salts and other dairy and nondairy ingredients followed by heating and continuous mixing to form a homogeneous product Over the past century", the manufacturing of processed cheese has grown substantially, resulting in the creation of a wide range of products all over the world. Processed cheese was typically divided into two categories: spreadable processed cheese and processed cheese, depending on the finished product's physical attributes (Smith, 1990). Processed cheese is defined by (Gulzar *et al.*, 2020) as a uniform blend of natural cheese types, vegetable oils, butter oil, milk solids, emulsifying salts, and additional dairy or nondairy ingredients with a longer shelf life. Processed cheese was created in response to the need to increase the shelf life of natural cheese, recycle cheese that was flawed, and create a cheese with unique flavor, texture, and useful qualities (Falih *et al.*, 2024). In Europe, processed cheese manufacture began in the early 1900s. Emulsifying salts (ES), like sodium phosphates and trisodium citrate (TSC), are frequently employed in the production of processed cheese to regulate melting, texture, and the creation of free oil (Meyer, 1973; Berger *et al.*, 1998 and Fox *et al.*, 2000). Since these compounds are not surface-active chemicals, they are not true emulsifiers in the literal sense of the word, unlike mono- or diglycerides. Enhancing the emulsifying ability of cheese proteins is ES's crucial processing function (Caric *et al.*, 1985). The development of ultrafiltration (UF) technology over the past 20 years has now enabled the manufacturing of low-lactose whey protein concentrates (WPC) at a comparatively low cost. Producing WPC with various physicochemical and functional characteristics for use in various food systems is now feasible thanks to this breakthrough technology. There are various types of whey that can be used in the production of processed cheese, including "sweet" whey (pH > 5.8) from cheddar, The production of fresh acid cheeses like Danbo, Queso Blanco, and others, as well as "medium" acid whey (pH 5.0 to 5.8) and "acid" whey (pH < 5.0) were obtained from the manufacturing of fresh acid cheeses like mozzarella and other similar cheeses or rennet casein.

The aim of this research: illustrated the effect of product type differences on the chemical, microbiological, rheological, and the organoleptic properties of processed cheese.

## MATERIALS AND METHODS

**Materials:**

1-**Ras cheese**: which made at Dairy Research Unit, Faculty of Agriculture Mansoura University was used in the experimental search.

2-**Kareish cheese**: made in Dairy Unit Faculty of Agriculture Mansoura University.

3-**Skim milk powder**: made in Poland by "Arla "

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4-**Palm oil:** imported from Indonsia. Two types of palm oil, from kernel and the other from the fruit.

**5-Emulsifying salts are:**

a- EGY Phos S20 (Egy Dairy Company - East-Egypt). b- Joha NO with corrector (made in Germany, both were bought from EGY Phos Company found in AL-Aasher of Ramadan/Sharkia Governorate

6- **Permeate**: obtained from Elshehab company in Mansoura city.

7- **Commercial grade salt** (NaCl), vegetable oil, white pepper, black pepper, garlic, pickled olive slices, Peanut, sweet lupine, baladi chick-pea and shami chick-pea were obtained from the local market.

**Methods:**

**Manufacture of processed cheese spread**:

The dairy department of the Faculty of Agriculture at Mansoura University used the batch method to create processed cheese spread in accordance with the procedure outlined by El-Assar (1991). Table (1) shows the ingredients (%) for the processed cheese base.

**Table 1. The composition Processed cheese base ingredients (%).**

| | % | Chemical analysis | | | |
|---|---|---|---|---|---|
| | | Fat/TS | TS% | Fat % | Protein % |
| Ras cheese | 10_20% | 54.88 | 62.35 | 34.22 | 25.21 |
| Kareish cheese | 20-30 | 0.02 | 25.00 | 0.5 | 21.2 |
| Skim milk powder | 8-12% | 0.01 | 96.0 | 0.10 | 34.00 |
| Palm oil | 20-30% | 100 | 100 | 100 | 0.0 |
| Emulsifying salt | 1-3% | 0.00 | 99.30 | 0.00 | 0.00 |
| Water | 20-25% | 0.0 | 0.00 | 0.00 | 000 |
| Permeate | | 7.13 | 5.61 | 0.4 | 0.49 |
| Total | 100 | | | | |

**1-Chemical analysis:**

**-Total Solids:** Total Solids content of processed cheese, soft and hard cheese was deter-mined as described by the Association of Official Analytical Chemists (A.O. A.C., 1990).

- **Nitrogen contents** (Total nitrogen): The total nitrogen of the processed cheese was measured by the micro-Kjeldahl method as recommended by the (A.O.A.C., 1990).
- **Fat content:** The fat content of processed cheese analogues, vegetable protein cakes were determined using soxhelet apparatus according to (A.O.A.C., 1990).
- **Treatable acidity**: The process outlined by Ling (1963) was used to determine the processed cheese's treatable acidity.
- **pH values:** Using a digital pH meter (LTU Italy), the pH values were determined in control and processed cheese analogs.

**2-Organoleptic evaluation**:

As per the scheme reported by Hassan (1996), the processed cheese spread samples were organoleptically evaluated both during their fresh state and during the storage period. Regular scoring panels from Mansoura University's Faculty of Agriculture's dairy department conducted the assessment. For processed cheese spread, the scoring sheet looked like this:

**3-Microbial analysis**

Ten grams of the cheese sample were meticulously weighed in a sterile environment before being placed in a flame and alcohol-sterilized pestle. After putting 10 milliliters of a 20% sodium citrate solution in the mortar and grinding the cheese until it was a homogenous suspension, 80 milliliters of sterile saline solution that had been warmed to 37 degrees Celsius was added and thoroughly mixed to create the 1–10 dilution, which was used to prepare the serial dilution in accordance with the American Public Health Association (A.P.H.A., 1960).

**Total Bacterial Counts:**

According to the American Public Health Association (1978), the total bacterial count of cheese was ascertained by plating 1 milliliter of an appropriate dilution in duplicate using nutritional agar medium (Difco Manual, 1966). Prior to counting and documenting the results, plates were incubated for three days at 32°C.

**Aerobic spore forming counts:**

After ten minutes at 85°C in a water bath, tubes containing a variety of samples were allowed to cool to room temperature. Nutrient agar media were used to plate the samples in duplicate (Difco Manual, 1966). In accordance with the guidelines provided by the American Public Health Association (1980), the plates were incubated at 32°C for three days prior to counting.

**Coliform bacteria:**

Coliform bacterial count was determined according to (American Public Health

Association, 1960) by using MacConkey agar. The plates were incubated at 37°C for 48 hrs. before counting as described by (American Public Health Association, 1980).

**Staphylococci:**

For detecting and enumerating staphylococci, appropriate dilution of the examined cheese samples was plated with staphylococcus medium No.110 (Difco Manual, 1974) plates incubated at 37°C for 40-43 hrs.

**Moulds and yeasts:**

Potato dextrose agar being recommended by the (Oxoid Manual, 1962) was used for the enumeration of moulds and yeasts. Inoculated plates were incubated at 25°C for 5 days.

**4- Textural Analyses**

Using a texture analyzer (CNS/FARNELLFRA, Borechamwoad, Hertfordsimre, England), the texture characteristics of cheese samples were assessed. Fresh cheese samples were used for control and experimental purposes, and 60-day aid cheese samples that were stronger were measured right away. The dimensions of the cheese sample were 20 mm in height and 30 mm in circumference. The speed was 1 mm/s, and the penetration distance was 10 mm. At least twenty minutes before testing, the samples were left to stand at room temperature. The perplex cone TA15-450C probe was utilized. Using an LFRA texture analyzer and a computer interface, the texture profile parameters were computed after data was gathered on a computer. The texture profile characteristics described by Bourne (1978) were determined and obtained as follows:

i) The hardness is measured by the compressive force (g) obtained at maximum compressive during the initial bite. ii) As a cohesiveness metric, the ratio of the positive force area under the curve during the first compression (a2/a1) to that during the second compression (bite).

iii) As a measure of springiness, the height (mm) to which the sample recovered during the clamping period between the conclusion of the first bite and the beginning of the second bite.

iV) Gumminess is measured as the product of hardness and cohesiveness (g). V) A measure of chewiness, calculated

as the product of gumminess and springiness (g.mm). Vi) The modulus, which is the force slope that indicates the rigidity of the sample

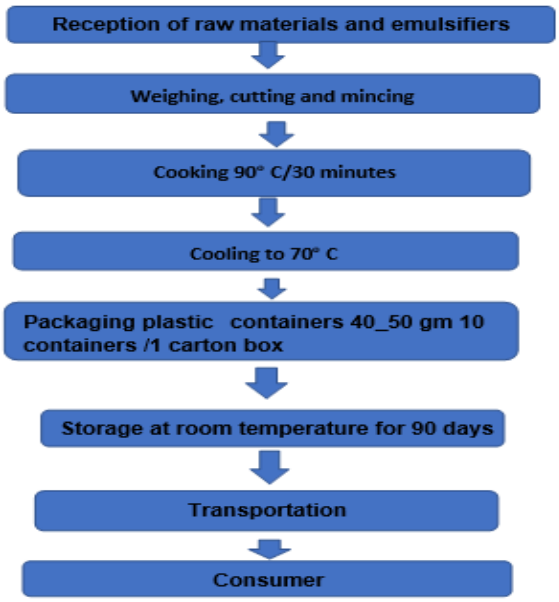


**Fig. 1. Steps for making processed cheese**

## RESULTS AND DISCUSSION

**pH Values**

Results from (Table 2) showed increased pH was observed with increasing permeate replacement ratio in all treatments, but with storage a decrease in pH values occurred. this is might by due to the existence of these organic preservatives, which prevented the growth of microorganisms while they were being stored. The pH of processed cheese is known to be closer to 5.7; block processed cheese has a lower pH, whereas processed cheese spread has a higher pH. Lactic acid was used to modify the pH values of cheese (Codex STAN-A-8(b)-1978). The pH and acidity levels of processed cheese were not included in (Egyptian Standards E.S 1132/2013).

**Table 2. chemical composition of processes cheese made from different ratio of permeate.**

| Treatments | Storage periods | pH | Acidity | T.S % | TP % | Fat % | Fat/ DM |
|---|---|---|---|---|---|---|---|
| Control | Fresh | 5.22 | 0.23 | 44.69 | 8.76 | 19.22 | 43.01 |
| | 30 | 5.22 | 0.24 | 44.88 | 8.78 | 19.23 | 42.85 |
| | 60 | 5.21 | 0.24 | 44.91 | 8.79 | 19.27 | 42.91 |
| | 90 | 5.20 | 0.25 | 45.12 | 8.81 | 19.31 | 42.80 |
| P1 (25 %) | Fresh | 5.23 | 0.21 | 46.68 | 8.77 | 19.13 | 40.98 |
| | 30 | 5.22 | 0.22 | 47.12 | 8.78 | 19.20 | 40.75 |
| | 60 | 5.22 | 0.24 | 47.53 | 8.78 | 19.31 | 40.63 |
| | 90 | 5.20 | 0.25 | 47.73 | 8.79 | 19.32 | 40.48 |
| P2 (50%) | Fresh | 5.24 | 0.22 | 47.01 | 8.78 | 18.91 | 40.23 |
| | 30 | 5.23 | 0.23 | 47.67 | 8.81 | 19.00 | 39.86 |
| | 60 | 5.22 | 0.25 | 47.85 | 8.82 | 19.15 | 40.02 |
| | 90 | 5.21 | 0.26 | 48.03 | 8.83 | 19.17 | 39.91 |
| P3 (75 %) | Fresh | 5.30 | 0.23 | 48.35 | 8.81 | 19.1 | 39.50 |
| | 30 | 5.28 | 0.23 | 48.55 | 8.82 | 19.19 | 39.53 |
| | 60 | 5.23 | 0.25 | 48.71 | 8.83 | 19.23 | 39.48 |
| | 90 | 5.22 | 0.26 | 49.81 | 8.84 | 19.44 | 39.03 |
| P4 (100%) | Fresh | 5.31 | 0.24 | 48.68 | 8.82 | 19.64 | 40.35 |
| | 30 | 5.30 | 0.24 | 49.12 | 8.83 | 19.66 | 40.02 |
| | 60 | 5.28 | 0.25 | 49.53 | 8.84 | 19.69 | 39.75 |
| | 90 | 5.26 | 0.26 | 49.73 | 8.85 | 19.82 | 39.86 |

**Titratable acidity**

In the same trend the acidity increased at 90 days storage periods which P1(25%), P2 (50%) P3 (75%) and P4 (100%) recorded highest values of acidity in comparing to other storage periods. The range of acidity in both fresh and preserved cheese was 0.20 to 0.30 percent. The values that were obtained are accurately correlated with the pH values. While the current results were consistent with Timothy *et al.* (2009), the acquired results were not in agreement with those reported by Metwaly *et al.* ,(2007).

**Total Solids content**

Total solids percentage T.S% increased with replacement ratio recorded highest values at P4 (100%) 49.73% in comparing other treatments either the control fresh processed cheese or after at 90 days storage periods. Egyptian Standards (E.S. 1132/2013) address manufactured cheese that contains vegetable oils. There should be at least 45% total solids. Five samples of each of the six processed cheese brands produced and marketed in India were examined by (Boghra *et al.*, 2006); the moisture content ranged from 44.9 to 48.68%.

**Total protein content**

The treatment P4 (100%) recorded the highest total protein (T.P%) 8.85at 90 days storage periods in comparing to other treatments and control either fresh cheese or during storage periods. Because the cheese's moisture level has decreased, the protein content of the control cheese seems to be higher. The permitted percentage of protein was not included in the Egyptian Standards (E.S1132/2013). Similarly, the legality of protein was not mentioned in Codex STAN-A8 (b) (1978). In addition to skim milk powder (SMP), a significant proportion of Ras and Kariesh cheese is used to produce our fresh processed cheese, which has a high protein content (18.00-24.34%).

**Total Fat content**

The treatment P4 (100%) recorded highest fat content 19.64 to 19.82 at fresh cheese or after 90 days of storage periods. For all treatments, processed cheese had a higher fat content. The fat content marginally rose as the storage period went on. The cheese's increased total solids are the cause of the apparent rise. The findings were consistent with those of Metwaly *et al.*, (2007).

**Fat/Dry matter**

On the other hands the P3 (75%) recorded the lowest Fat/DM 39.03 at 90 days storage periods which P3 at 90 days of storage periods recorded highest values in comparing to other treatments. Egyptian Standards (E.S1132/2013) listed Fat/DM not less than 65% for high cream cheese and not less than 35% for whole fat cheese as well 25-35 for half cream cheese, low fat cheese 10-25% fat cheese.

The obtained results are similar to those reported by (Awaad *et al.*, 2020); (Lara *et al.*, 2021)and (Bandyopadhaya *et al.*, 2024).

Data presented in Table 3 showed the effect of replacement water with permeate cheese on microbiological properties processes cheese. The treatment P4 (100%) recorded highest values of T.C*$10^3$ and M&Y *$10^3$ 17 and 13 respectively and Microbiological analysis was conducted during the storage period, starting with fresh treatments, and the analysis process continued at 30 days and 60 days until the end of the storage period at 90 days. It was noted in the following table that as the storage period increased, the total count content and the content of Molds and Yeasts increased for all treatments. It was also noted that all treatments were not detect of coliform bacteria and staphylococcus aureus during the storage period. The obtained results are similar to those reported by (Awaad *et al.*, 2020); (Lara *et al.*, 2021)and Bandyopadhaya *et al.*, 2024).

**Table 3. Microbiological properties of processes cheese made from different ratio of permeate.**

| Treatments | Storage periods | T.C *10³ | M&Y *10³ | E. coli *10³ | Staph *10³ |
|---|---|---|---|---|---|
| Control | Fresh | 2 | ND | ND | ND |
| | 30 | 3 | 1 | ND | ND |
| | 60 | 7 | 2 | ND | ND |
| | 90 | 11 | 4 | ND | ND |
| P1 (25 %) | Fresh | 3 | ND | ND | ND |
| | 30 | 5 | 6 | ND | ND |
| | 60 | 9 | 7 | ND | ND |
| | 90 | 12 | 9 | ND | ND |
| P2 (50%) | Fresh | 5 | ND | ND | ND |
| | 30 | 8 | 3 | ND | ND |
| | 60 | 11 | 4 | ND | ND |
| | 90 | 13 | 6 | ND | ND |
| P3 (75 %) | Fresh | 6 | ND | ND | ND |
| | 30 | 8 | 3 | ND | ND |
| | 60 | 11 | 5 | ND | ND |
| | 90 | 15 | 7 | ND | ND |
| P4 (100%) | Fresh | 7 | ND | ND | ND |
| | 30 | 10 | 4 | ND | ND |
| | 60 | 12 | 7 | ND | ND |
| | 90 | 17 | 9 | ND | ND |

(Table 4) presented the effect of replacement water with permeate cheese on rheological properties processes cheese. From collected data the treatment of P4 (100 %) recorded the highest values of Hardness (N) 104.04, while Cohesiveness (ratio), Springiness (mm), and Gumminess (N) decrease 35.5,0.26,13.57 and 15.83 respectively at fresh cheese . The obtained results are similar to those reported by (Awaad *et al*., 2020; Lara *et al*., 2021 and Bandyopadhaya *et al*., 2024).

**Table 4. Rheological properties of processes cheese made from different ratio of permeate.**

| Treatments | Storage periods | Control | P1 (25%) | P2 (50 %) | P3 (75 %) | P4 (100 %) |
|---|---|---|---|---|---|---|
| Hardness (N) | Fresh | 91.4 | 94.00 | 97.60 | 101.10 | 104.04 |
| | 90 | 73.4 | 77.00 | 86.80 | 90.90 | 96.00 |
| Adhesiveness (mj) | Fresh | 60.81 | 57.90 | 41.9 | 36.3 | 35.5 |
| | 90 | 50.8 | 45.5 | 30.4 | 27.20 | 23.9 |
| Cohesiveness (ratio) | Fresh | 0.37 | 0.31 | 0.27 | 0.26 | 0.22 |
| | 90 | 0.26 | 0.29 | 0.26 | 0.24 | 0.19 |
| Springiness (mm) | Fresh | 7.75 | 13.15 | 12.45 | 13.22 | 13.57 |
| | 90 | 10.98 | 14.04 | 15.92 | 14.93 | 15.83 |
| Gumminess (N) | Fresh | 23.4 | 20.0 | 19.0 | 18.4 | 15.30 |
| | 90 | 42.4 | 36.04 | 33.1 | 29.5 | 28.0 |
| Chewiness (mj) | Fresh | 481 | 264 | 336 | 270 | 207 |
| | 90 | 365 | 230 | 255 | 233 | 171 |

On the other hand's during storage periods decrease in Hardness, Adhesiveness, cohesiveness, chewiness and increased springiness, gumminess days of storage periods.

**Hardness (N):**

It is defined as the force needed to achieve a specific deformation and is correlated with the strength of the cheese matrix. It is also a measure of the force needed to compress the cheese treatment. The hardness value increased for all treatments after the processed cheese was refrigerated for ninety days. This is due to the addition of emulsifying that led to the formation of additional iso peptide bonds, and the production of a gelatinous network with smaller aggregates and smaller pore sizes (Imm *et al.,* 2000).

**Springiness (mm):**

Defined as the ratio of which a distorted material returns to its main form when removing the distorting strength Szczesniak *et al.,* (1963). On the other hand, the Springiness of the control treatment increased during the first 90 days, and the results showed an increase in the Springiness value for all treatments at the end of storage compared to the control treatment.

**Cohesiveness (%)**

Defined as the force of internal bonds forming the body of the product Bourne (1978) and Szczesniak *et al.,* (1963). Cohesiveness values decreased gradually by the gradually addition of retentates amount in fresh processed cheese (Table,4). On the other hand, the Cohesiveness of the control treatment decreased during the

first 90 days, and the results showed adecrease in the Cohesiveness value for all treatments at the end of storage compared to the control treatment. A decrease in the Cohesiveness value for treatment at the end of storage. The obtained results are in accordance with Ossman. E. (2018).

**Gumminess (N):**

Defined as the power required to disintegrate a semi-solid food for swallowing Szczesniak *et al.,* (1963). Table (4) showed that addition of retentates increase the processed cheese values for some treatments, the gumminess increased from for fresh and 90 days storage respectively. The results showed an increase in the gumminess value for all treatments at the end of storage and an increase in the gumminess value for all treatment in fresh. The results obtained are consistent with Othman. E. (2018).

**Chewiness (J):**

The energy needed to chew a solid food item is called chewiness, and it is related to other textural characteristics like cohesion, hardness, and springiness (Prakasan *et al.,* 2015 and Salinase-valdes *et al.,* 2015). Chewiness values decreased gradually in fresh processed cheese (Table,5).

**Table 5. The effect of replacement water with permeate cheese on organoleptic properties processes cheese.**

| Treatments | Storage periods | Flavor (40) | Int app (30) | Outer app (30) b | Total |
|---|---|---|---|---|---|
| Control | Fresh | 36 | 27.5 | 26.5 | 90 |
| | 30 | 36 | 26 | 26 | 88 |
| | 60 | 35 | 25.5 | 25.5 | 86 |
| | 90 | 35 | 25.0 | 25 | 85 |
| P1 (25 %) | Fresh | 36 | 25.0 | 24 | 85 |
| | 30 | 35 | 25.0 | 24 | 84 |
| | 60 | 35 | 24 | 24 | 83 |
| | 90 | 33 | 23 | 23 | 79 |
| P2 (50% | Fresh | 38 | 27 | 26 | 91 |
| | 30 | 37 | 27 | 25 | 89 |
| | 60 | 36 | 26 | 25 | 87 |
| | 90 | 34 | 24 | 25 | 83 |
| P3 (75 %) | Fresh | 38 | 28 | 26 | 92 |
| | 30 | 37 | 27 | 26 | 90 |
| | 60 | 36 | 26.5 | 25.5 | 88 |
| | 90 | 35 | 25 | 25 | 85 |
| P4 (100%) | Fresh | 38 | 28.5 | 27.5 | 94 |
| | 30 | 38 | 28 | 27 | 93 |
| | 60 | 36 | 27 | 26 | 89 |
| | 90 | 36 | 26 | 26 | 88 |

On the other hand, values decreased by storage time, the results showed a decrease in the. Chewiness value of all treatments. The obtained results are in accordance with Salinas-Valdés *et al*., (2015). The obtained results are similar to those reported by (Awaad *et al*., 2020; Lara *et al*., 2021 and Bandyopadhaya *et al*., 2024).

Data presented in Table 4 showed the effect of replacement water with permeate cheese on organoleptic properties processes cheese. Results indicated that long storage periods affect the flavor which lowest values at 90 days storage periods and the best flavor recorded at 30 days of storage periods in comparing no storage (fresh). The best flavor recorded 38 at 30 days storage periods in treatment of P4 (100%). The organoleptic properties processes cheese affected by long storage periods. The obtained results are

similar to those reported by (Awaad *et al*., 2020; Lara *et al*., 2021 and Bandyopadhaya *et al*., 2024).

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# تأثير استبدال الماء بنسب مختلفة من الراشح الناتج من الترشيح الفائق على خواص وجودة الجبن المطبوخ


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## الملخص


في هذا البحث تم دراسة تأثير استبدال الماء المستخدم في صناعة الجبن المطبوخ بنسب مختلفة من البريميت **permeate** على الخواص الكيمائية والميكروبيولووجية والريولوجية والحسية للجبن المطبوخ وكانت النتائج كالتالي: تم ملاحظة زيادة المواد الصلبة الكلية للجبن المطبوخ مع زيادة نسبة الاستبدال من الراشح حتى وصلت نسبة الاستبدال إلى ١٠٠٪ وكانت (٤٩,٧٣٪) وكذلك زيادة كل من البروتين والدهن (١٩,٦٤-٨,٨٢٪) مع زيادة نسبة الاستبدال وكذلك انخفضت نسب الدهن / المادة الصلبة (٤٠,٣٥٪) وتم ملاحظة زيادة قيم الأس الهيدروجيني (٥,٣١) مع زيادة نسبة الاستبدال وانخفاضه مع التخزين ونفس التأثير العكسي بالنسبة للحموضة في كل العينات. بالنسبة للخواص الميكربيولوجية والعد البكتيري لوحظ مع زيادة نسبة الاضافة زاد العد الكلي للميكروبات وكانت أقل الأعداد في العينة الكنترول وكانت ٢×١٠^٣ بينما زادت الأعداد مع التخزين حيث وصلت في نهاية التخزين الي ١١×١٠^٣ كذلك حدث زيادة غير ملحوظة لأعداد الفطريات والخمائر مع زيادة نسبة الاستبدال وكذلك خلال فترة التخزين وكانت أقل الأعداد في العينة الكنترول سواء في الجبن الطازج أو بعد ٩٠ يوم (١-٩ ×١٠^٣) بينما بالنسبة للكوليفورم والبكتريا العنقودية كانت غير موجودة سواء في الجبن الطازج أو في نهاية التخزين. بالنسبة للخواص الريولوجية زادت الصلابة للجبن وانخفضت باقي الخواص الريولوجية مع زيادة نسبة الاستبدال وكانت الخواص الحسية للجبن سواء الطعم او القوام والمظهر أفضل مع زيادة نسبة الاستبدال حتى ١٠٠ ٪