# Effect of dryer & drying methods and production time on the quality and safety of dried yoghurt during storage

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**Abstract**. The main objective of this research is to study the effect of drying, drying methods and production time on the quality & safety of dried yoghurt and effect of storage on it. 4 kg of natural yoghurt freshly produced during the first day of shelf life, and 4 kg after expiration date (day 11), the samples were dried using two method, spray drying process and the traditional method, dried yoghurt samples were stored at room temperature after being packed in an unsealed plastic container for 3 months. The experiment was conducted in *Samsung* /turkey, in Ondokuz Mayis university, Department of food Engineering labs. Chemical, physical, microbiological and sensory analysis of raw and dried yoghurt samples were performed before and during storage. The results of the study showed that drying significantly affects all properties of yoghurt. The moisture content (1%) was affected by drying as moisture decreased by great rate of more than (70%) ($P \leq 0.05$), moisture was also affected by small amount by the storage; Protein content % was significantly increased by drying from (4.020%) in the raw yoghurt produced during production shelf life, and (3.217%) in the yoghurt produced after expiration date to (7.177%) in average, the protein content values were not affected by the storage in the dried samples by the spray drying method. Drying significantly ($P \leq 0.05$) affect the values of fat content where the values increased after expiration date to (13%) in average, and the value were not affected by the storage. The non-fatty solids content significantly ($P \leq 0.05$) increased by drying, has become an average of (77.00%) after drying. Acidity value ratio increased by drying and storage by meager percentage, the pH value significantly decreased ($P \leq 0.05$) by drying and storage at a significantly rate. Total Solids % was significantly affected ($P \leq 0.05$) by drying and storage as it increased from (16.42%) in the raw yoghurt (during production shelf life) and (14.69%) in the raw yoghurt (after expiration date) to become more than (90%) by drying. As for the microbial content; the total bacteria value decreased by drying, but were not affected by storage, also lactic acid bacteria values reduced significantly ($P \leq 0.05$) by drying, but remained the same during storage. However, the total count of yeast, molds, E-coli bacteria was not found in the raw yoghurt and has not grown during storage. In the sensory evaluation, the panelists preferred a raw yoghurt and dried yoghurt in the first month, and then the rate and values of the sensory evaluation decreased significantly ($P \leq 0.05$) during storage. The study concluded that, the validity of yoghurt can be extended by drying, and taking advantages of yoghurt in the last day by drying and storing it.

**Keyword:** Yoghurt; Drying; Production Time; Storage.

## 1. Introduction

Fermented foods are regarded as popular household products and since early times have formed an integral part of the human diet [1][2]. LAB as Functional Cultures Cultures for the Food Fermentation Industry. Starter cultures provide a basis in the production of fermented foods. Lactic acid starter cultures are the most important group of bacterial starter cultures [3]. There are many reports indicating the industrial importance of these cultures for the manufacture of fermented foods [4][5].

Drying is one of the oldest technologies of food preservation. It involves removal of water from food materials to lower the free moisture content to an acceptable level. The removal of free moisture lowers the water activity and thus prevents the microbial growth and other moisture mediated deterioration [13]. It substantially reduces the packaging, storage and transportation costs and also enables the storability of product at ambient conditions. Solubility is one of the key indicators of quality of spray dried powders. Ease of reconstitution makes the product attractive for use in households or as ingredient in food formulations. The amorphous powders have better solubility; however, they are less stable during processing and storage.

The importance of yogurt as part of a balanced and healthy diet is recognized by regulatory authorities and scientific institutions in most countries [6]. Yogurt is defined by The Codex standard as the product of milk fermentation by Lactobacillus delbrueckii subspecies bulgaricus and Streptococcus thermophilus [7].

Yogurt powder, produced by drying of fresh yogurt, can be used as an ingredient for the manufacturing of many food products such as confectioneries, bakery foods, yogurt drink mixes with fruits or vegetables, instant drink mixes, soup bases, dips, and sauces as well as for direct consumption after reconstitution [5][8]. The important and objectives of this study to increase the shelf life of yoghurt, provide a new product and access to the best drying way to produce dried yogurt, but the research problem to prolong the period of validity of yogurt because most of the companies and factories producing yogurt stationed in the capital, making it difficult for the product in other states and remote areas, additionally difficulty of transport, storage and high in costs.

## 2. Materials And Methods

### *2.1. Yogurt samples preparation*

Yogurt samples were obtained from the local markets, Samsun state, Turkey. Laboratory analysis was carried out in the laboratories of the University of ONDOKUZ MAYIS, where the experience of drying the yogurt in the Department of food Engineering, Spry dryer (mini spray dryer b-290), hand mixer, Sensitive Balance, packing materials, Colander, tinfoil, stainless steel spoons, drying facilities.

### *2.2. Drying processing*

Natural yoghurt first day and expired day production dried by two types (spry dryer and Traditional drying), then samples was storage in containers at room temperature 3 months. Use a drying machine (mini spray dryer b-290) with a capacity of 2 liters. Mix the natural yogurt sample with a hand mixer to be homogenized. The air inlet is set to 170c degrees, air outlet temperature 94c, 100% aspirator, 35% flow, drying time 2-3 hours, Production efficiency every 2 liters given 40 grams. Mini Spray Dryer B-290: The BUCHI Mini Spray Dryer B-290 is easy to operate and can be used with a small quantity of materials. Use to dry the yogurt incubation heat shield 55 degrees for 48 hours, after freezing the yogurt in a refrigerator temperature below 5 degrees Celsius and separate the water in a water bath temperature of 48 degrees and filtered with a filter put the solid material in aluminum foil and then placed in the incubators and are refilled and Crushed and packaged and storage. Drying time 2-3 days, Production efficiency every 2 liters

given150 grams. After drying the yogurt was filled in plastic containers sterilized and the lock and stored at room temperature for 3 months until analyzed every month.

*2.3. Physicochemical, microbial and sensory analysis*

Chemical, physical, microbial and sensory analyzed before and after drying. Moisture contents Titratable acidity (%) of yoghurt were determined gravimetrically by oven drying at 102c for 2 h [9]. Total solid, Protein and Fat measured by Milk Oscan, FOSS Analytical A/S.69, Slangeruggade, and DK3400 Hillerod Denmark, the solids-fat-content was determined from the following equation: SNF (%) = TS%_F%. The pH of samples was determined using electronic pH meter (JENWAY 3510 pH Meter, designed and manufactured in the UK by Bibby Scientific Stone LTd, model 3510, serial no. 51030). Fat, protein and total solid determined by using food scan (s/n3187671061, foss analytical A/S, slangeruggade, and dk3400 hollered Denmark) Microbiological analysis according to [10]. Sensory evaluation test determined according to scoring test. panelists' acceptance of color, taste, odor, texture and overall acceptability, according to [11].

*2.4. Statistical analysis*

All Data were subjected to statically analysis using Statistical Analysis System (SAS). significant differences between Means were determined by Duncan's Multiple Range Test (DMRT) at $p < 0.05$, as reported by [12].

**3. Results And Discussion**

Moisture content (%): As shown in (Figure 1), moisture content (%) was affected by drying and storage by drying method and time of yoghurt production. The results showed that the highest mean moisture content (%) of raw yoghurt was (86.73) in the samples after the expired in the traditional drying method and spray drying method respectively, and (85.30) in the samples during the production in the traditional drying method and spray drying method respectively. The results showed there was no significant different ($P\leq 0.05$) between all samples dried by spray drying method during storage period.

The results showed a significant difference ($P\leq 0.05$) in moisture content in traditional drying method. The results showed that the drying methods decreased the moisture content (%) significantly ($P\leq 0.05$) after drying to less than 10%. The study showed that storage has a significant ($P\leq 0.05$) effect on the moisture content. Moisture was significantly ($P\leq 0.05$) decreased in dried yogurt samples during the traditional and after-expiration periods, while the storage period did not affect the moisture content of spray dried yogurt samples. Decreased of moisture content after drying Evaporation of water may be caused by the drying of raw yogurt. The increased moisture content of dried yogurt in the traditional drying method way compared to the spray drying method may be due to the uncontrolled drying time and temperature Stability of moisture content during storage for yogurt samples drying with the spray drying method may be controlled by drying time and temperature.

Protein content (%): As shown in (Figure 2), Protein content (%) was affected by drying and storage by drying method and time of yoghurt production. The results showed that the highest mean Protein content (%) of raw yoghurt was (4.020) in the samples during the production in the traditional drying method and spray drying method respectively, and (3.217) in the samples after the expired in the traditional drying method and spray drying method respectively. The results showed a significant difference ($P\leq 0.05$) between the protein content in the traditional drying method during production and after expiration during the storage period except for the first and second months, while there was no significant difference ($P\leq 0.05$) in the protein content in the spray drying method. Protein content significantly ($P\leq 0.05$) increased

after drying to more than 7% in all drying methods except traditional drying method. The protein content during storage in the third and fourth months decreased to less than 5%.

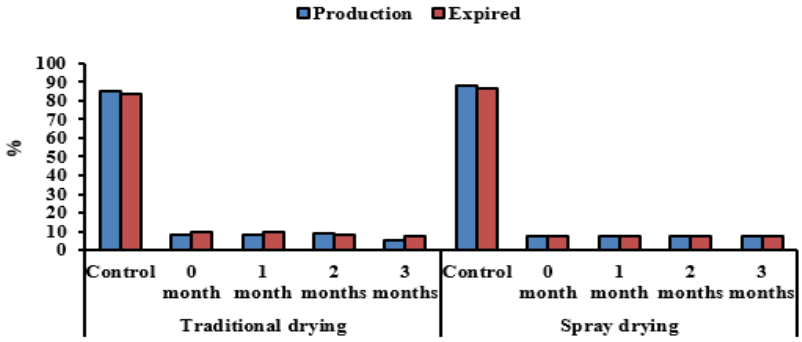


Figure 1: Moisture content of yoghurt as affected by drying method, product time and storage period

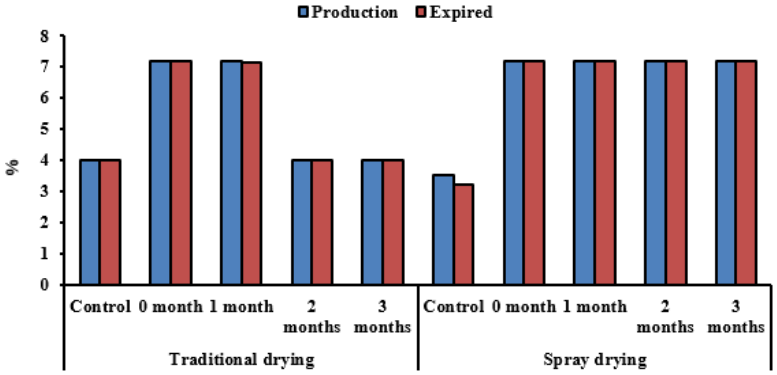


Figure 2: Protein of yoghurt as affected by drying method, product time and storage period

The study showed that storage had a significant (P≤ 0.05) effect on the protein content of the dry yogurt by traditional method during the production period and after expiration, while the storage period did not significantly (P≤ 0.05) affect the protein content of the dried yogurt in a spray drying method. Increased protein content after drying it may be to increase the concentration of yogurt due to the drying of raw yoghurt. A decrease in the protein content of the dried yogurt in the traditional drying method during storage in the last two months compared to the spray drying method may be due to non-control of traditional drying method, which leads to protein breakdown during storage. The stability of the protein content of the dried yogurt in the drying method during storage may be due to the control of the conditions of the spray drying method.

Fat content (%): As shown in (Figure 3), fat content (%) was affected by drying and storage by drying method and time of yoghurt production. The results showed that the highest mean fat content (%) of raw yoghurt was (3.73) in the samples during the production in the traditional drying method and spray drying method respectively, and (3.33) in the samples after the expired in the traditional drying method and spray drying method respectively. The results showed that the drying method had a significant (P≤ 0.05) effect on the fat content of the dried yogurt in the traditional drying method way during production and after the expiry, where the fat content increased significantly (P≤ 0.05). While there were no significant (P≤ 0.05)

differences in the fat content during the production period and after the expiration of the dried yogurt in the spray drying method.

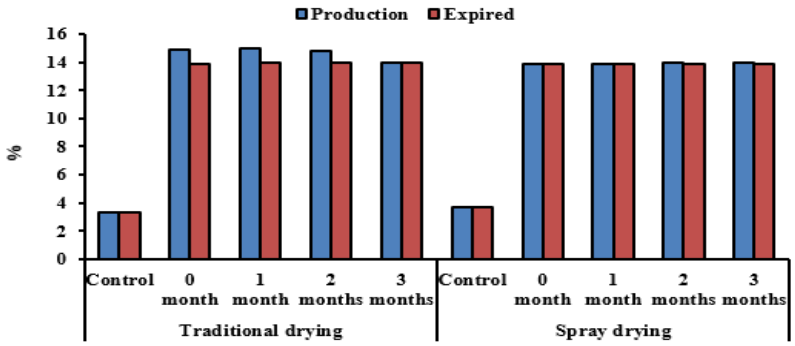


Figure 3: Fat content of yoghurt as affected by drying method, product time and storage period

The results showed that the drying methods significantly (P≤ 0.05) increased the fat content after drying, to more than 13%. The study showed that storage had a significant (P≤ 0.05) effect on the fat content of the dry yogurt by traditional method during the production period and after expiration, while the storage period did not significantly (P≤ 0.05) affect the fat content of the dried yogurt in a spray drying method. Increased fat content after drying it may be to increase the concentration of yogurt due to the drying of raw yoghurt. The fat content of the dried yogurt may be unstable in the traditional drying method during storage due to lack of control over drying method conditions. The stability of the fat content of the dried yogurt in the drying method during storage may be due to the control of the conditions of the spray drying method.

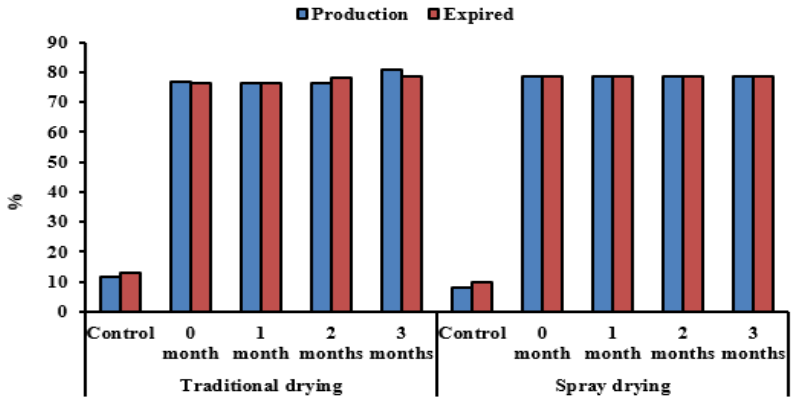


Figure 4: SNF of yoghurt as affected by drying method, product time and storage period

SNF content (%): As shown in (Figure 4), SNF content (%) was affected by drying and storage by drying method and time of yoghurt production. The results showed that the highest mean the SNF content (%) of raw yoghurt was (13.20) in the samples during the production in the traditional drying method and spray drying method respectively, and (11.49) in the samples after the expired in the traditional drying method and spray drying method respectively. The results showed that the drying method had a significant (P≤ 0.05) effect on the SNF content of the dried yogurt in the traditional drying method way during production and after the expiry, where the SNF content increased significantly (P≤ 0.05). While there were did not significant differences (P≤ 0.05) in the SNF content during the production period and after the expiration of the dried yogurt in the spray drying method. The results showed that the drying methods significantly (P≤ 0.05) increased the SNF content after drying, to more than78%. The study showed that.

storage had a significant (P≤ 0.05) effect on the SNF content of the dry yogurt by traditional method during the production period and after expiration, while the storage period did not significantly (P≤ 0.05) affect the SNF content of the dried yogurt in a spray drying method. Increased SNF content after drying it may be to increase the concentration of yogurt due to the drying of raw yoghurt. The SNF content of the dried yogurt may be unstable in the traditional drying method during storage due to lack of control over drying method conditions. The stability of the SNF content of the dried yogurt in the drying method during storage may be due to the control of the conditions of the spray drying method.

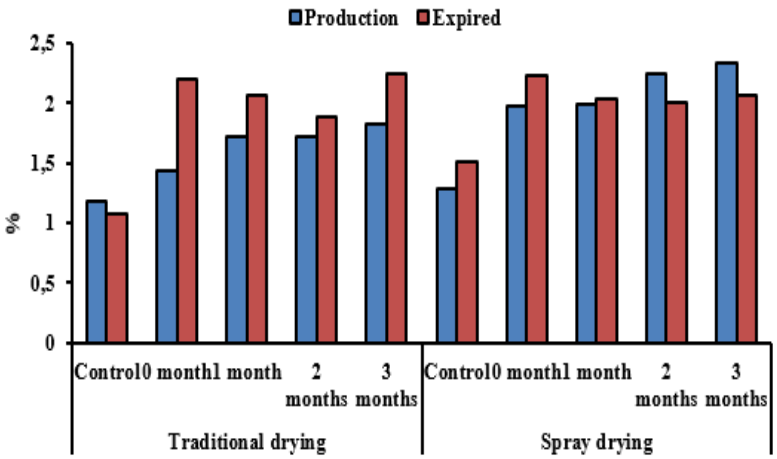


Figure 5: Titratable acidity of yoghurt as affected by drying method, product time and storage period

Titratable acidity content (%): As shown in (Figure 5) acidity content (%) was affected by drying and storage by drying method and time of yoghurt production. The results showed that the highest mean acidity content (%) of raw yoghurt was (1.510) in the samples after the expired in the traditional drying method and spray drying method respectively, and (1.180) in the samples during the production in the traditional drying method and spray drying method respectively. The results showed that the drying method had a significant (P≤ 0.05) effect on the acidity content of the dried yogurt in the traditional drying method and spray drying method together way during production and after the expired, where the acidity content increased significantly (P≤ 0.05). The results showed that the drying methods significantly (P≤ 0.05) increased the acidity content after drying, to more than 2%. The study showed that storage had a significant (P≤ 0.05) effect on the acidity content of the dry yogurt by traditional method and spray drying method together during the production period and after expiration Where acidity content has increased significantly (P≤ 0.05). Increased acidity content after drying it may be to increase the concentration of yogurt due to the drying of raw yoghurt. Increased acidity content during the storage period of the drying yogurt by traditional method and spray drying method together during the production period and after expiration It may be to decrease the pH and found lactic Acid bacteria.

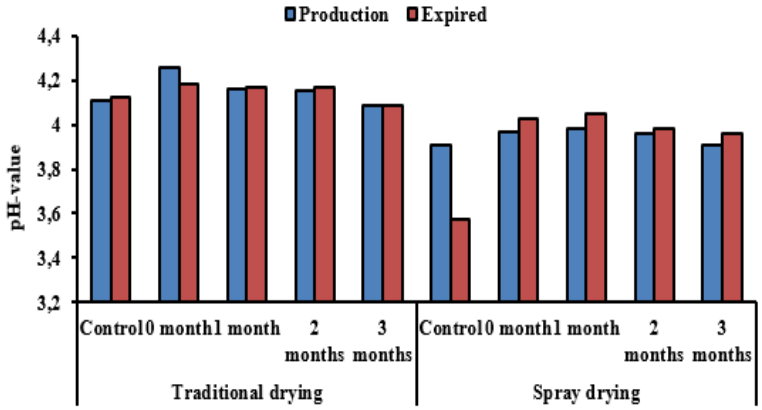


Figure 6: PH of yoghurt as affected by drying method, product time and storage period

PH Value: As shown in (Figure 6) PH was affected by drying and storage by drying method and time of yoghurt production. The results showed that the highest mean the PH of raw yoghurt was (4.113) in the samples during the production in the traditional drying method and spray drying method respectively, and (3.913) in the samples after the expired in the traditional drying method and spray drying method respectively. The results showed that the drying method had a significant ($P \leq 0.05$) effect on the PH of the dried yogurt in the traditional drying method and spray drying method together way during production and after the expiry, where the PH (%) increased significantly ($P \leq 0.05$). The results showed that the drying methods significantly ($P \leq 0.05$) increased the PH (%) after drying, to more than 4%. The study showed that storage had a significant ($P \leq 0.05$) effect on the PH of the dry yogurt by traditional method and spray drying method together during the production period and after expiration Where PH (%) Where they decreased significantly ($P \leq 0.05$). Decreased pH content during the storage period of the drying yogurt by traditional method and spray drying method together during the production period and after expiration It may be to increase the acidity and found lactic Acid bacteria.

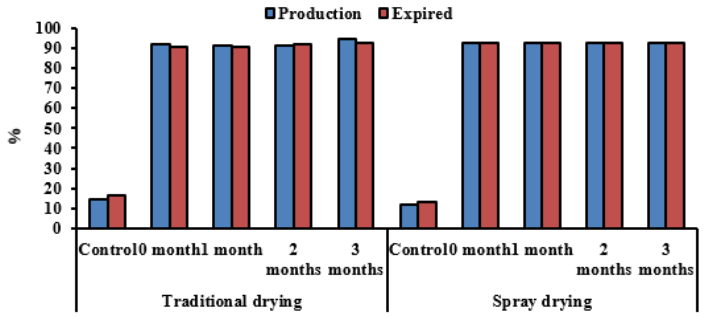


Figure 7: Total solids of yoghurt as affected by drying method, product time and storage period

Total solids (%): As shown in (Figure 7) Total solids (%) was affected by drying and storage by drying method and time of yoghurt production. The results showed that the highest mean the PH (%) of raw yoghurt was (16.42) in the samples during the production in the traditional drying method and spray drying method respectively, and (14.69) in the samples after the expired in the traditional drying method and spray drying method respectively. The results showed that the drying method had a significant ($P \leq 0.05$) effect on the Total solids (%) of the dried yogurt in the traditional drying method way during production and after the expiry, where the Total solids (%) increased significantly ($P \leq 0.05$). While there

were did not significant differences (P≤ 0.05) in the Total solids (%) during the production period and after the expiration of the dried yogurt in the spray drying method. The results showed that the drying methods significantly (P≤ 0.05) increased the Total solids (%) after drying, to more than 92%. The study showed that storage had a significant (P≤ 0.05) effect on the Total solids (%) of the dry yogurt by traditional method during the production. period and after expiration, while the storage period did not significantly (P≤ 0.05) affect the Total solids (%) of the dried yogurt in a spray drying method. Increased Total solids (%) after drying it may be to increase the concentration of yogurt due to the drying of raw yoghurt. The Total solids (%) of the dried yogurt may be unstable in the traditional drying method during storage due to lack of control over drying method conditions. The stability of the Total solids (%) of the dried yogurt in the drying method during storage may be due to the control of the conditions of the spray drying method.

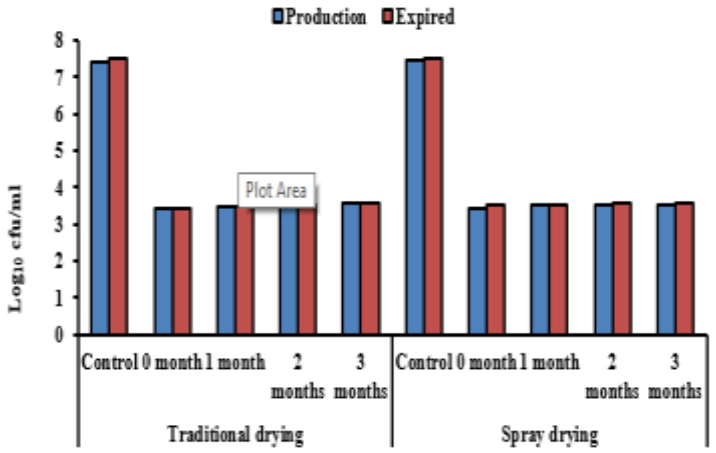


Figure 8: Total viable count of bacteria of yoghurt as affected by drying method, product time and storage period

Total viable count of bacteria ($log^{10}$ cfu/ml): As shown in (Figure 8) Total viable count of bacteria ($log^{10}$ cfu/ml) was affected by drying and storage by drying method and time of yoghurt production. The results showed that the highest mean Total viable count of bacteria ($log^{10}$ cfu/ml) of raw yoghurt was (7.530) in the samples after the expired in the traditional drying method and spray drying method respectively, and (7.490) in the samples during the production in the traditional drying method and spray drying method respectively. The results showed that the drying method had a significant (P≤ 0.05) effect on the Total viable count of bacteria ($log^{10}$ cfu/ml) of the dried yogurt in the traditional drying method and spray drying method together way during production and after the expiry, where the Total viable count of bacteria ($log^{10}$ cfu/ml) Decreased significantly (P≤ 0.05). The results showed that the drying methods significantly (P≤ 0.05) decreased the Total viable count of bacteria ($log^{10}$ cfu/ml after drying, to less than4.0%. The study showed that storage had a significant (P≤ 0.05) effect on the Total viable count of bacteria ($log^{10}$ cfu/ml) of the dry yogurt by traditional method and spray drying method together during the production period and after expiration Where Total viable count of bacteria ($log^{10}$ cfu/ml) where they decreased significantly (P≤ 0.05). Decreased Total viable count of bacteria ($log^{10}$ cfu/ml) after drying it may be to kill the bacteria by heat-drying. Increased Total viable count of bacteria ($log^{10}$ cfu/ml) gradually during storage period it may be to Bacteria growth during storage when sampling for analysis and moisture leakage.

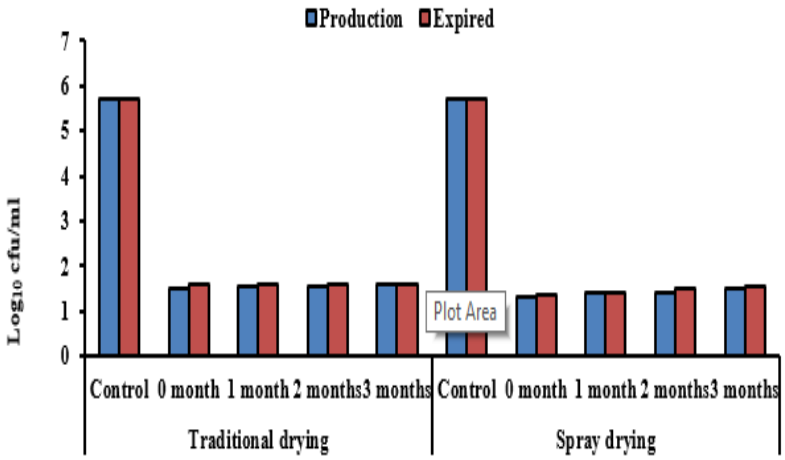


Figure 9: Lactobacillus of yoghurt as affected by drying method, product time and storage period

Lactobacillus ($log^{10}$ cfu/ml): As shown in (Figure 9), Lactobacillus (%) was affected by drying and storage by drying method and time of yoghurt production. The results showed that the highest mean Lactobacillus (%) of raw yoghurt was (5.720) in the samples after the expired in the traditional drying method and spray drying method respectively, and (5.700) in the samples during the production in the traditional drying method and spray drying method respectively. The results showed that the drying method had a significant ($P \leq 0.05$) effect on the Lactobacillus ($log^{10}$ cfu/ml) of the dried yogurt in the traditional drying method and spray drying method together way during production and after the expiry, where the Lactobacillus ($log^{10}$ cfu/ml) Decreased significantly ($P \leq 0.05$). The results showed that the drying methods significantly ($P \leq 0.05$) decreased the Lactobacillus ($log^{10}$ cfu/ml) after drying, to less than2.0%. The study showed that storage had a significant ($P \leq 0.05$) effect on the Lactobacillus ($log^{10}$ cfu/ml) of the dry yogurt by traditional method and spray drying method together during the production period and after expiration Where Lactobacillus ($log^{10}$ cfu/ml) where they decreased significantly ($P \leq 0.05$). Decreased Lactobacillus ($log^{10}$ cfu/ml) after drying it may be to kill the bacteria by heat-drying. Increased Lactobacillus ($log^{10}$ cfu/ml) gradually during storage period it may be to Bacteria growth during storage when sampling for analysis and moisture leakage.

Yeasts and moulds MPN/ml): Yeasts and moulds no found in raw yoghurt and were not affected by drying and storage by drying method and time of yoghurt production, Yeast and moulds no growth during and after storage.

*E. coli* (MPN/ml): *E. coli* no found in raw yoghurt and were not affected by drying and storage by drying method and time of yoghurt production, Yeast and moulds no growth during and after storage.

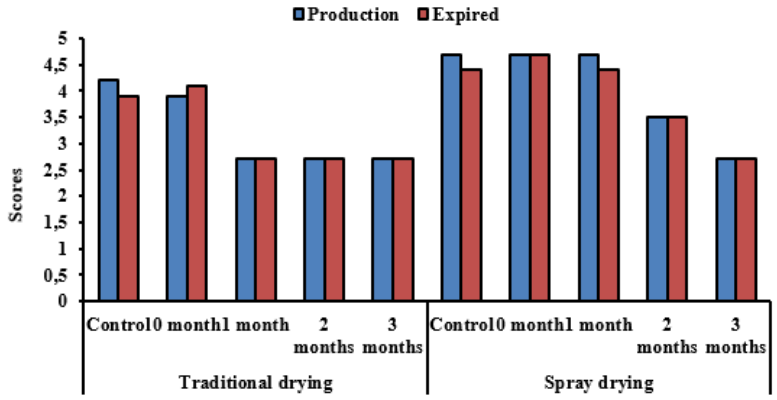


Figure 10: Color of yoghurt as affected by drying method, product time and storage period

Sensory Evaluation (5 Scouring Test)- Color degree: As shown in (Figure 10) color degree was affected by drying and storage by drying method and time of yoghurt production. The results showed that the highest mean color degree of raw yoghurt was (4.70) in the samples during the production and (4.40) after the expired in the spray drying method and (4.20) in the samples during production and (3.90) after the expired in traditional drying method. The results showed that the drying method had a significant ($P \leq 0.05$) effect on the color degree of the dried yogurt in the traditional drying method and spray drying method together way during production and after the expiry, where the color Decreased significantly ($P \leq 0.05$). The results showed that the drying methods significantly ($P \leq 0.05$) decreased the color degree after drying, to less than3%. The study showed that storage had a significant ($P \leq 0.05$) effect on the color degree of the dry yogurt by traditional method and spray drying method together during the production period and after expiration color degree Where they decreased significantly ($P \leq 0.05$). Decreased color degree after drying it may be to heat on yoghourt protein the effect of heat on yoghourt protein.

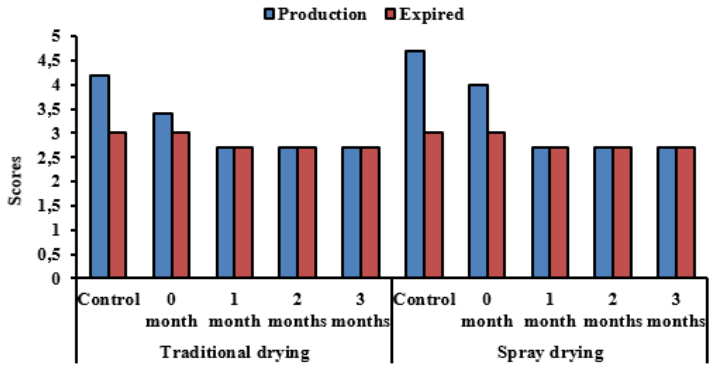


Figure 11: Taste of yoghurt as affected by drying method, product time and storage period

Sensory Evaluation (5 Scouring Test)- Taste: As shown in (Figure 11) the Taste was affected by drying and storage by drying method and time of yoghurt production. The results showed that the highest mean the Taste of raw yoghurt was (4.70) in the samples during the production and (3.00) after the expired in the spray drying method and (4.20) in the samples during production and (3.00) after the expired in traditional drying method. The results showed that the drying method had a significant ($P \leq 0.05$) effect on

the Taste of the dried yogurt in the traditional drying method and spray drying method together way during production and after the expiry, where the Taste Decreased significantly (P≤ 0.05). The results showed that the drying methods significantly (P≤ 0.05) decreased the Taste after drying, to less than3%. The study showed that storage had a significant (P≤ 0.05) effect on the Taste of the dry yogurt by traditional method and spray drying method together during the production period and after expiration the Taste Where they decreased significantly (P≤ 0.05).

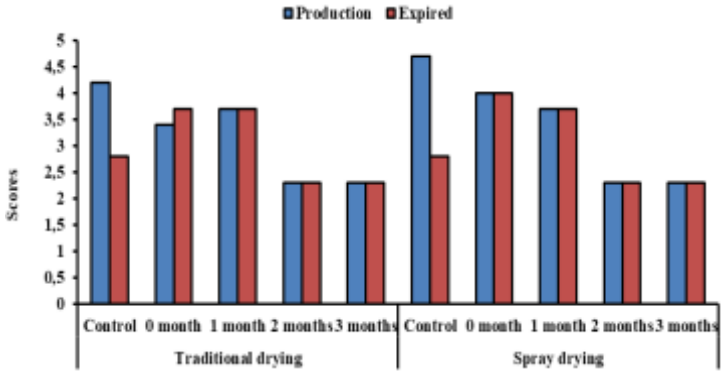


Figure 12: Oder of yoghurt as affected by drying method, product time and storage period

Sensory Evaluation (5 Scouring Test) Odor as showed in (Figure 12) the oder was affected by drying and storage by drying method and time of yoghurt production. The results showed that the highest mean the Odor of raw yoghurt was (4.70) in the samples during the production and (3.00) after the expired in the spray drying method and (4.20) in the samples during production and (3.00) after the expired in traditional drying method. The results showed that the drying method had a significant (P≤ 0.05) effect on the Odor of the dried yogurt in the traditional drying method and spray drying method together way during production and after the expiry, where the Odor Decreased significantly (P≤ 0.05). The results showed that the drying methods significantly (P≤ 0.05) decreased the Odor after drying, to less than3%. The study showed that storage had a significant (P≤ 0.05) effect on the Odor of the dry yogurt by traditional method and spray drying method together during the production period and after expiration the Odor Where they decreased significantly (P≤ 0.05).

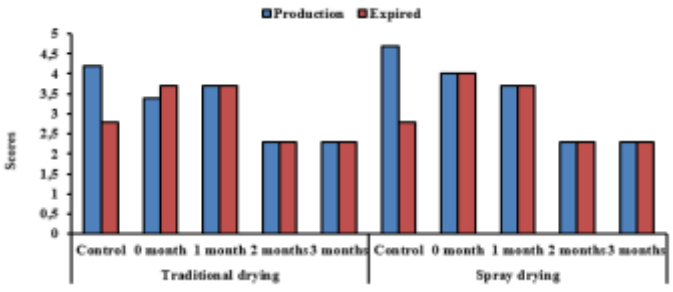


Figure 13: Texture of yoghurt as affected by drying method, product time and storage period

Texture: As shown in (Figure 13) the texture was affected by drying and storage by drying method and time of yoghurt production. The results showed that the highest mean the Texture of raw yoghurt was (4.70) in the samples during the production and (2.80) after the expired in the spray drying method and

(4.20) in the samples during production and (2.80) after the expired in traditional drying method. The results showed that the drying method had a significant (P≤ 0.05) effect on the Texture of the dried yogurt in the traditional drying method and spray drying method together way during production and after the expiry, where the Texture Decreased significantly (P≤ 0.05). The results showed that the drying methods significantly (P≤ 0.05) decreased the Texture after drying, to less than3%. The study showed that storage had a significant (P≤ 0.05) effect on the texture of the dry yogurt by traditional method and spray drying method together during the production period and after expiration the Texture Where they decreased significantly (P≤ 0.05).

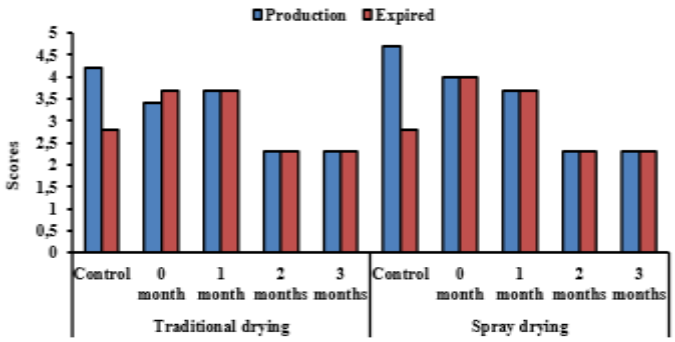


Figure 14: Texture of yoghurt as affected by drying method, product time and storage period

General acceptability: As shown in (Figure 14) the General acceptability was affected by drying and storage by drying method and time of yoghurt production. The results showed that the highest mean the General acceptability of raw yoghurt was (4.70) in the samples during the production and (2.80) after the expired in the spray drying method and (4.20) in the samples during production and (2.80) after the expired in traditional drying method. The results showed that the drying method had a significant (P≤ 0.05) effect on the General acceptability of the dried yogurt in the traditional drying method and spray drying method together way during production and after the expiry, where the General acceptability Decreased significantly (P≤ 0.05). The results showed that the drying methods significantly (P≤ 0.05) decreased the General acceptability after drying, to less than3%. The study showed that storage had a significant (P≤ 0.05) effect on the General acceptability of the dry yogurt by traditional method and spray drying method together during the production period and after expiration the General acceptability Where they decreased significantly (P≤ 0.05).

## 4. Conclusion

The study concluded that raw yogurt can be dried and stored and reuse after moisturizing. The raw yoghurt can be lengthened by drying, save it and storing for three months without damage. The method of the spray drying is better than the traditional drying method. Three-month storage of samples with no microbial growth with slight changes in product color.

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