



The Effect of Ground (*Myrtus communis*) on Prolonging the Shelf Life of Soft Cheese

Israa Ahmed¹, Hanan Aqduo¹, Taha Mohammed¹

10.18805/ajdfr.DRF-658

ABSTRACT

Background: The dairy industry expresses a tendency towards natural preservatives to extend the shelf life of products, especially for soft cheeses which are very prone to spoilage. Myrtle (*Myrtus communis*) is known for its antibacterial and antioxidant properties. This study aimed to evaluate, with respect to consumer acceptance optimization, the role of ground myrtle leaves as a natural preservative to modify the chemical, microbiological and sensory properties of fresh cheese during 21 days of storage.

Methods: The experiment design was arranged in completely randomized design with three treatments namely: T0 control (without adding additives), T1 with dosage of myrtle powder 0.5 g and T2 with dosage of myrtle powder 1 g. Samples were analyzed for microbiological and chemical parameters after 1, 7, 14 and 21 days of storage. A trained panel also scored on flavor and overall quality of samples.

Result: It was concluded that the inclusion of ground myrtle caused slight decrease of moisture content and slight increase of protein with no considerable effects on fat, ash content and pH of meat upon comparing to control sample. The addition did not totally prevent microbial growth - however, it clearly inhibited coliform growth; this inhibition was significant and treatment T2 was the most effective, exhibiting the lowest counts of microbial groups throughout storage time. In terms of the sensory aspect, the highest rating of control sample was observed within the first six days (96 on day 1) and T2 showed a lower taste stability and slower sensory deterioration over the tested period compared to the control ($P < 0.05$) with a significantly lower rating due to longer storage time ($P < 0.05$).

Key words: Chemical tests, Ground, Microbial content, Sensory properties, Storage period.

INTRODUCTION

Myrtle fruit (*Myrtus communis* L.), a member of the myrtle family, is a well-known medicinal and fragrant plant. This includes two or more genera of one species, in its entirety. Fruit-3 cm long and 1 cm long, an elliptical evergreen tree. Its leaves are numerous, long and green in color. Flowers are solitary, white, located in the leaf axils (Alipour *et al.*, 2014; Jabri *et al.*, 2018a).

The therapeutic and physiological properties of myrtle berries are strongly due to their high level of bioactive secondary metabolites. The most important of these antioxidants are anthocyanins which provide better protection against the oxidation process along with antimicrobial and anti-inflammatory actions. Similarly, the chemical composition of berries is a combined mixture of an essential oil, organic acids and tannins. The berries themselves are high in soluble carbohydrates, ascorbic acid (vitamin C), vital minerals and pectin-aiding better digestive function. Myrtle berries are highly enriched in bioactive compounds, primarily anthocyanins demonstrating biological functionality with antioxidant, antimicrobial and anti-inflammatory activity, essential oils, organic acids and tannins. Besides pectin, which has a prebiotic effect (Mohammadi *et al.*, 2021; Yegin *et al.*, 2022; Sirivella *et al.*, 2025), the berries also include sugars, vitamin C and necessary minerals.

Cheese is among the most significant dairy product. It is produced by causing milk proteins (casein) to coagulate

¹University of Mosul, College of Agriculture and Forestry, Mosul 41001, Iraq.

Corresponding Author: Israa Ahmed, University of Mosul, College of Agriculture and Forestry, Mosul 41001, Iraq.

Email: israa.maan@uomosul.edu.iq

How to cite this article: Ahmed, I., Aqduo, H. and Mohammed, T. (2026). The Effect of Ground (*Myrtus communis*) on Prolonging the Shelf Life of Soft Cheese. *Asian Journal of Dairy and Food Research*. **45(5)**: 780-786. doi: 10.18805/ajdfr.DRF-658.

Submitted: 09-02-2026 **Accepted:** 05-05-2026 **Online:** 22-05-2026

using bacterial starters or enzymes. Due to its high content of high-biological-value proteins and essential minerals, it possesses special nutritional properties. Due to its physicochemical stability, it can be transported or stored easily and thus is a critical component of the global food systems. However, cheese is a good medium for unwanted microbes to grow on it which increases its biological spoilage and lowers down its quality as well as safety on consumers. Due to this technical trouble, research has been consequently oriented to find natural active compounds as potential alternatives for chemical preservatives. Since then, plant extracts and essential oils have exhibited considerable efficacy against pathogens and preserving products (Kim *et al.*, 2019; Hamam *et al.*, 2020; Sheet *et al.*, 2026).

Studies concerning the evaluation of dairy technology involving the natural bioactives derived from plants have

centered on their innovative technological incorporation into them, along with their functional and biological interactions occurring following food matrixes' copresence (Abdel-Fattah *et al.*, 2022). The well-known technical approaches exist to add plant parts, spices or extracted volatile oils in the manufacturing of cheese that enhances its sensory and chemical properties (Granotto *et al.*, 2018).

The research gap covers the still unresolved problem of rapid spoilage created by bacteria in soft cheeses and the growing economic need to replace chemical preservatives with safe bioavailable ones. Myrtle is widely used as an antioxidant and antimicrobial in laboratory conditions; however, there are no scientific data evaluating the impact of its direct application at different concentrations on the chemical and sensory characteristics of fresh cheese and how it can allow to meet a compromise between extending durability while preserving flavor acceptability among consumers. This study aimed to assess the potential of myrtle fruit powder as a natural preservative of fresh cheese for 21 days in storage through decreasing of microbial loads, monitoring chemical composition changes and sensory quality.

MATERIALS AND METHODS

Preparation of myrtle ground

Preparing myrtle powder is a multi-step process that begins with rinsing the berries in distilled water to remove any dirt. Next, they are air dried at 40°C for 24 hours, preventing the degradation of heat-labile compounds. Next, the dried berries are ground into a fine powder, greatly increasing their surface area. Finally, the powder is placed in airtight glass containers and stored at 4°C to maintain chemical stability and prevent oxidation.

The ground myrtle fruit was obtained as shown in the Fig 1:

Cheese manufacturing and testing

Soft cheese was manufactured from cow's milk according to the method described by Fox (2017), with some modifications. The addition of dried myrtle fruit powder at a

concentration of 0.5 g per 100 g of soft cheese was used, designated as treatment (T1) and the addition of ground myrtle at a concentration of 1 g per 100 g of soft cheese was used, designated as treatment (T2). The two treatments were compared with a control sample, designated as (T0). The following tests were conducted:

Standardized international protocols are used for chemical tests that help figure out the basic parts of the cheese sample. We used the Subramanian and Rodriguez-Saona (2010) to guess the moisture content, the Lee and Kim (2008) to accurately measure the fat content and the AOAC (2012) to guess the protein content by multiplying the nitrogen content by the dairy conversion factor of 6.38. For the mineral content, the ash content was calculated using the Marshall method (2010) and the pH was measured at 25°C using the method of Larionov *et al.* (2020) by mixing equal parts of the sample and distilled water to make sure the results were correct.

Total bacterial counts and coliform counts were estimated using nutrient agar and MacConkey agar, respectively, according to Raquib *et al.* (2021), with incubation at 37°C for 24 hours. Total fungal counts were estimated using the casting method with PDA medium and incubation at 25°C for five days (Frank and Yousef, 2004).

The sensory evaluation of the cheese was conducted by ten evaluators (5 men and 5 women) from the Department of Food Science, College of Agriculture and Forestry, University of Mosul, using the Khalaf (2011) questionnaire, which assessed taste, color, aroma, texture and consistency.

We used a completely randomized design (CRD) with three copies of each treatment to make sure the results were correct and to reduce the chance of making mistakes during the experiment. We used the advanced software SAS (2012) and Duncan's Multiple Range Test to compare the means of the treatments at a significance level of $P < 0.05$.

RESULTS AND DISCUSSION

Chemical content

The data in Table 1 show a trend of decrease in moisture content throughout most of the storage period and such

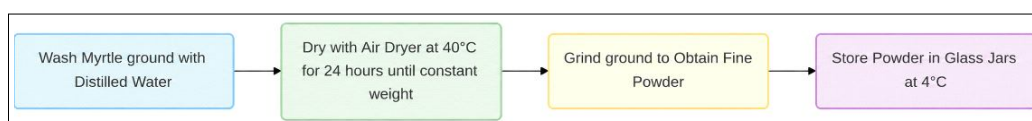


Fig 1: How to get ground myrtle date.

Table 1: Impact of treatments on cheese's moisture content while it is being stored.

Treatment	Storage period/day			
	1	7	14	21
T0	60.50a	59.88c	58.10e	55.45h
T1	60.00b	59.89c	58.18f	56.30g
T2	59.90b	60.10a	59.22d	56.50g

*T1: Cheese sample with 0.5 g of myrtle powder added, T2: Cheese sample with 1 g of myrtle powder added and T0: Control sample. The average of three replicates is shown in the figures. Significant differences at the 0.05 probability level are indicated by different letters.

decrease seem to be considerable on all treatments. The statistical differences between the later stages (days 14, 21) and the first stage was significant with no significant differences by the first stages. The control treatment (T0) had the highest moisture (60.50%) on the first day, whereas this number decreased gradually with treatment T2 on day 21 which had the lowest moisture value (56.50%). The drop in cheese pH (0.41) was explained scientifically based on osmotic property and protein network throughout the process of adding myrtle berry powder into the initial cheese mixture, this conforms with the work of (El-Sayed *et al.* (2025) when different plant powders are used. These additional fibers and solids facilitate syneresis, which is the separation of whey. It allows the whey to leave and evaporate from the cheese easier. Powder particles also function as physical substrates that promote curd cohesion and gratify the expulsion of free water which, together, can also clarify why cheese with added plant powders hold lower moisture compared to the control samples. These findings replicate those by Ribas *et al.* (2019) in their work regarding the influence of vegetable-derived additives on the textural characteristics of cheeses.

Table 2 the protein content results, apparent in treatments T1 and T2, showed a statistical difference determined by the storage time. The first phase (days 1 and 7) showed stable values in a relatively narrow range, which then increased slowly, reaching a maximum on day 21. The protein content was the highest value shown for treatment T1 at the end of the storage period (17.19%) with primary value treatment (T2) at the beginning of the experiment (17.90%), with this result confirming previously reported findings by Bosnea *et al.* (2020) who stated that soft cheese enriched with *Spirulina platensis* has a higher protein value. This with gradual rise in protein concentration

is explained by continued evaporation of moisture from the samples till the total solids including protein becomes more concentrated. Similarly, the differences in the stability of the values in treatment T1 illustrate the importance of bioactive compounds in myrtle berries. Phenols and terpenes act as antioxidants and microbial inhibitors by nature (Shahidi and Ambigaipalan, 2015), limiting the activity of proteolytic enzymes produced by microbes and of importance in retaining the integrity of protein structures and averting quality deterioration during storage.

Table 3 influence from treatments on values measured during different storage periods (T0, T1 and T2); values followed by different letters in the columns represent significant difference ($p < 0.05$) of cheddar cheese fat percentage. Fat values steadily increase over the course of days for all treatments, peaking on day 21. On first day T0: 19.44% and T1 19.68% and on day seven both 19.79, indicating that no significant difference between each treatment for first and seventh day. This means that these two treatments had similar initial effects at the start of the storage period. However, the first day (18.98%) and the seventh day (18.79%) effect of treatment T2 was less than that for the other two treatments, which indicates T2 had a different effect at the initial treatment stage. Nevertheless, by 14th and 21st day the effect of the treatments seems to visually separate; by reflection 21st day all treatment groups have different growth. The day 14 was characterized by the minimum value (20.49%) registered for treatment T2, whereas the values recorded for treatments T0 and 1 were similar (21.52% for T0 and 21.49% T1). Lipid results The highest associated with lipid saved in T was 24.17% of all the treatments for time 21 while the T1 and T2 were one hair distance with 23.32% and 23.36% respectively, These total results slim with the ones from Hashish *et al.* (2018)

Table 2: Impact of treatments on cheese's protein content while it is being stored.

Treatment	Storage period/day			
	1	7	14	21
T0	17.14g	17.15e	17.17c	17.19a
T1	17.10h	17.11f	17.13d	17.18b
T2	17.90i	17.90i	17.10h	17.18b

*T1: Cheese sample with 0.5 g of myrtle powder added, T2: Cheese sample with 1 g of myrtle powder added and T0: Control sample. The average of three replicates is shown in the figures. Significant differences at the 0.05 probability level are indicated by different letters.

Table 3: Impact of treatments on cheese's fat content while it is being stored.

Treatment	Storage period/day			
	1	7	14	21
T0	19.44c	19.79c	21.52b	24.17a
T1	19.68c	19.79c	21.49b	23.32a
T2	18.98d	18.79d	20.49c	23.36a

*T1: Cheese sample with 0.5 g of myrtle powder added, T2: Cheese sample with 1 g of myrtle powder added and T0: Control sample. The average of three replicates is shown in the figures. Significant differences at the 0.05 probability level are indicated by different letters.

who observed that incorporation of grape seeds increased fat content in soft cheese. It should stressed that the stability or variability of measured lipid values throughout the storage time are differentially affected by each treatments in the present study, given that a global increase of values regarding with the increasing of storage time was verified and also significant differences were noted in pairwise comparisons by treatments at the latter periods. Because ground myrtle is antibacterial, antioxidant and has water holding capacity abilities, as well as the propensity to interact with product ingredients, it serves as a type of preservative. And that, in turn, could have an impact on the future supply of cheese ingredients like fat. Some active phenolic compounds from myrtle studied by multiple authors, such as gallic acid and myricetin, are well known natural antioxidants (Farag *et al.*, 2020), so with the increase of myrtle in the composition, the antioxidant activity of the product was higher.

The results in Table 4 demonstrate that the final ash content determined remained very constant for all treatments evaluated (T1 and T2) during the evaluation period (days 1-21). All values were not significantly different and consistently stayed within a close range of 3.19% to 3.22%. Scientifically, this stability is because ash is the accumulation of inorganic matter. These inorganic compounds have relatively stable chemistry and do not decompose or interact with enzymatic processes the way proteins and fats do when stored. Also, those values did not vary after the incorporation of myrtle powder pointed out that the amount added was not enough to change the mineral balance of the elaborated product. That information correlates well with what Nielsen (2017) states regarding the stability of minerals in food upon different storage

methods and confirms the presence of minerals in the cheese.

Table 5 shows how treatments (T1 and T2) can affect the cheese pH values during storage periods. There was a slow decline up to days 1, 7 and 14 and a sharp rise on day 21. The values were similar for all treatments on day 1 (6.30-6.31), but decreased to 6.18-6.19 on day 7 and to 6.10-6.11 on day 14, the lowest value of the period of evaluation. This is because of the action of lactic acid bacteria. The pH increased significantly on day 21, up to 6.30 in one of the treatments, whilst the highest values were recorded for T1 and T2 (6.50 and 6.70, respectively). This is what Anwar *et al.* (2016) indicated: that extracts of myrtle and plants in general contribute to preventing food spoilage due to their antioxidant and antimicrobial properties.

Microbial content

Table 6 shows the impact of treatments T0, T1 and T2 on the microbiological evolution of cheese during storage periods. The numbers of total bacteria largely rose with storage time, but there were no significant differences on day 1 between cultured dilutions, whilst marked changes were observed on days 14 and 21. In day 21, the total bacterial count was 2.02 CFU/g, which is less than T0 with a value of 2.96 CFU/g (day 14). This results indicate the inhibitory effect of myrtle powder; as for treatment T1 and T2, supplemented with myrtle powder compared with control treatment T0 showed lower bacterial counts during storage period of most part. In the two storage periodic T1 and T2, treatment with no coliform were founded; however, in tree tests of T0 their concentrations increased to 1.00 ($p < 0.005$), 1.30, 1.30 and were recorded with a minimum on day one and maximum on day twenty-one respectively which are consistent with Derbassi *et al.* (2022).

Table 4: Impact of treatments on cheese's ash content while it is being stored.

Treatment	Storage period/day			
	1	7	14	21
T0	3.20a	3.20a	3.21a	3.19a
T1	3.21a	3.21a	3.20a	3.20a
T2	3.22a	3.21a	3.19a	3.20a

*T1: Cheese sample with 0.5 g of myrtle powder added, T2: Cheese sample with 1 g of myrtle powder added and T: Control sample. The average of three replicates is shown in the figures. Significant differences at the 0.05 probability level are indicated by different letters.

Table 5: Impact of treatments on cheese's pH content while it is being stored.

Treatment	Storage period/day			
	1	7	14	21
T0	6.30b	6.18c	6.10d	6.30b
T1	6.30b	6.19c	6.10d	6.50a
T2	6.31b	6.19c	6.11d	6.70a

*T1: Cheese sample with 0.5 g of myrtle powder added, T2: Cheese sample with 1 g of myrtle powder added and T0: Control sample. The average of three replicates is shown in the figures. Significant differences at the 0.05 probability level are indicated by different letters.

who described that extracts of *Arbutus unedo* leaves caused a decrease in the microbial load in cheese.

Until day 7, no fungal growth had been identified in any of the treatments (data not shown), while fungal growth was only detected in the T0 treatment at 14 days. At day 21, for treatments T0, T1 and T2 the fungal counts were of 1.69, 1.47 and 2.30 CFU/g; respectively, being thus higher values observed in control treatment. Authors attributed this effect to the active compounds from myrtle (tannins, flavonoids and phenolic compounds with antimicrobial activity), which not only reduce microbial load but also could improve microbiological characteristics of the cheese and prolong its shelf life (Nawafur *et al.*, 2024).

Sensory evaluation

The sensory evaluation results in Table 7 demonstrate the significant superiority of the treatments enriched with myrtle

extract in preserving the organoleptical (sensory) characteristics of the cheese over time. While the control sample experienced a sharp decline in total points from 96 to 84 due to deterioration in taste and texture, the treatment with 1% extract (T1) maintained exceptional quality, scoring 91 points on day 21. This scientific superiority of treatment T1 is attributed to the rich content of phenolic compounds and flavonoids in myrtle extract, which act as a dual defense. They function as natural antioxidants, preventing fat rancidity and flavor changes and as antimicrobial agents, inhibiting the growth of spoilage microorganisms that negatively affect texture and color. This vital role of the extract contributed to slowing down the chemical and biological reactions responsible for spoilage during storage, which enhances consumer acceptance of the product for longer periods and is consistent with what was confirmed by the studies of

Table 6: Impact of treatments on cheese's microbial content while it is being stored.

Microbial tests	Treatment	Storage period/day			
		1	7	14	21
Total bacterial count	T0	2.47a	2.94a	2.96a	2.02c
	T1	2.46a	2.69b	2.86b	2.94a
	T2	2.47a	2.63b	2.78b	2.90b
Coliform bacteria	T0	1.00a	1.30a	1.30a	1.77a
	T1	0.00b	0.00b	0.00b	0.00b
	T2	0.00b	0.00b	0.00b	0.00b
Fungi	T0	0.00b	0.00b	0.47b	1.69b
	T1	0.00b	0.00b	0.00b	1.47b
	T2	0.00b	0.00b	0.00b	2.30a

*T1: Cheese sample with 0.5 g of myrtle powder added, T2: Cheese sample with 1 g of myrtle powder added and T0: Control sample. The average of three replicates is shown in the figures. Significant differences at the 0.05 probability level are indicated by different letters.

Table 7: Impact of treatments on cheese's sensory evaluation while it is being stored.

Treatment	Storage period	Sensory properties				
		Taste and Flavor 40 degree	Texture 30 degree	Color 20 degree	Appearance 10 degree	Total properties 100 degree
T0	1	37a	29a	20a	10a	96a
	7	37a	28a	20a	10a	95a
	14	34b	28a	19a	10a	91b
	21	30c	27a	18a	9a	84c
T1	1	37a	29a	19a	10a	95a
	7	36a	28a	19a	9a	92a
	14	32b	27a	18a	9a	86b
	21	30c	27a	17a	8a	82c
T2	1	36a	30a	18a	9a	93a
	7	36a	29a	17a	9a	91a
	14	35a	29a	16a	8a	88b
	21	32b	28a	15a	7a	82c

*T1: Cheese sample with 0.5 g of myrtle powder added, T2: Cheese sample with 1 g of myrtle powder added and T0: Control sample. The average of three replicates is shown in the figures. Significant differences at the 0.05 probability level are indicated by different letters

Nikmaram *et al.* (2018) regarding the ability of plant extracts rich in phenols to extend shelf life and improve the sensory properties of foods.

CONCLUSION

The present research report quantifies that 1 gram dose of Myrtle leaf powder (*Myrtus communis*) (T2) is a novel and new natural source available in market to improve quality of soft cheese and to enhance soft cheese shelf life. The addition was successful in inhibiting microbial growth, especially coliform bacteria. The moisture content was reduced in the wheat flour end products, which provided a barrier to microbes, ensuring stability of chemical traits such as ash and pH, as well as enabling increase of protein content. Sensory quality was initially better in the control sample, but fortified treatments had improved sensory stability and taste and texture scores that did not deteriorate as quickly as those of the control sample over a 21-day period. Plant phenols have various antioxidant and antimicrobial properties to provide this. Myrtle's powder should be added during fresh cheese making to improve nutrition and safety in the same time period without sacrificing palatability in longtime.

Conflict of interest

All authors declare that they have no conflict of interest.

REFERENCES

- A.O.A.C (2012). Official methods of analysis, Association of Official Analytical Chemists, Gaithersburg, USA, 19th edn. https://scholar.google.com/scholar?hl=arand_as_sdt=0%2C5andq=A.O.A.C+%282012%29.+Official+methods+of+analysis%2C+Association+of+Official+Analytical+Chemists%2C+Gaithersburg&btnG=.
- Abdel-Fattah, M., Cooper, D., Davidson, T., Kilonzo, M., Hossain, M., Boyers, D. and Norrie, J. (2022). Single-incision minislings for stress urinary incontinence in women. *New England Journal of Medicine*. **386(13)**: 1230-1243. <https://doi.org/10.1056/NEJMoa21118>.
- Alipour, G., Dashti, S. and Hosseinzadeh, H. (2014). Review of pharmacological effects of *Myrtus communis* L. and its active constituents. *Phytotherapy Research*. **28**: 1125-1136. <https://doi.org/10.1002/ptr.5122>.
- Anwar, S., Ahmed, N., Al Awwad, N., Ansari, S.Y. and Wagih, M.E. (2016). Myrtle (*Myrtus communis* L.) Oils. In: *Essential Oils in Food Preservation, Flavor and Safety*. Academic Press. pp. 581-592. <https://doi.org/10.1016/B978-0-12-416641-7.00066-3>.
- Bosnea, L., Terpou, A., Pappa, E., Kondyli, E., Mataragas, M. and Markou, G. (2020). Incorporation of *Spirulina platensis* on traditional Greek soft cheese with respect to its nutritional and sensory perspectives. *Proceedings*. **70**: 99. https://doi.org/10.3390/foods_2020-07600.
- Derbassi, N., Pedrosa, M.C., Heleno, S., Fernandes, F., Dias, M.I., Calhella, R.C. and Barros, L. (2022). Arbutus unedo leaf extracts as potential dairy preservatives: Case study on quark cheese. *Food and Function*. **13(9)**: 5442-5454. <https://pubs.rsc.org/en/content/articlelanding/2022/fo/d1fo04158d/unauth>.
- El-Sayed, S.M., Youssef, A.M. and El-Sayed, H.S. (2025). Innovative dairy-based products featuring vegetables: A complementary technique with promising perspectives. *Journal of Food Measurement and Characterization*. **19(11)**: 8165-8181. <https://doi.org/10.1007/s11694-025-03570-6>.
- Farag, R.S., Abdel-Latif, M.S., Abd El Baky, H.H. and Tawfeek, L.S. (2020). Phytochemical screening and antioxidant activity of some medicinal plants' crude juices. *Biotechnology Reports*. **28**: e00536. <https://doi.org/10.1016/j.btre.2020.e00536>.
- Fox, P.F., Guinee, T.P., Cogan, T.M. and McSweeney, P.L. (2017). Overview of cheese manufacture. In *Fundamentals of cheese science* (chapter 1). Springer US. 11-25. https://www.researchgate.net/publication/306387395_Overview_of_Cheese_Manufacture.
- Frank, J.F. and Yousef, A.E. (2004). Tests for Groups of Microorganisms. In: *Standard Methods for the Examination of Dairy Products*. Wehr, [H.M. and Frank, J.F. (Ed)]. 17th edition. Washington, American Public Health Association. (Chapter 8). pp. 187-226. <https://ajph.aphapublications.org/doi/book/10.2105/9780875530024>.
- Granato, D., Santos, J., Salem, R., Mortazavian, A., Rocha, R. and Cruz, A.G. (2018). Effects of herbal extracts on quality traits of yogurts, cheeses, fermented milks and ice creams: A technological perspective. *Current Opinion in Food Science*. **19**: 1-7. <https://doi.org/10.1016/j.cofs.2017.11.013>.
- Gutiérrez-del-Río, I., Fernández, J. and Lombó, F. (2018). Plant nutraceuticals as antimicrobial agents in food preservation: Terpenoids, polyphenols and thiols. *International Journal of Antimicrobial Agents*. **52(3)**: 309-315. <https://doi.org/10.1016/j.ijantimicag.2018.04.024>.
- Hammam, A.R., Elfarruk, M.S., Ahmed, M.E. and Sunkesula, V. (2020). Characteristics and technological aspects of the Egyptian cheeses. *International Journal of Current Microbiology and Applied Sciences*. **9(6)**: 3338-3354. <https://doi.org/10.20546/ijcmas.2020.906.397>.
- Hashish, E., Merwad, A., Elgaml, S., Amer, A., Kamal, H., Elsadek, A. and Sitohy, M. (2018). Mycobacterium marinum infection in fish and man: Epidemiology, pathophysiology and management; A review. *Veterinary Quarterly*. **38(1)**: 35-46. <https://doi.org/10.1080/01652176.2018.1447171>.
- Jabri, M. A., Marzouki, L. and Sebai, H. (2018a). Ethnobotanical, phytochemical and therapeutic effects of *Myrtus communis* L. berries seeds on gastrointestinal tract diseases: A review. *Archives of Physiology and Biochemistry*. **124(5)**: 390-396. <https://doi.org/10.1080/13813455.2017.1423504>.
- Kim, K.T., Hwang, J.E., Eum, S.J. and Paik, H.D. (2019). Physiochemical analysis, antioxidant effects and sensory characteristics of quark cheese supplemented with ginseng Extract. *Food Science of Animal Resources*. **39(2)**: 324. <https://doi.org/10.5851/kosfa.2019.e26>.
- Larionov, G., Semenov, V., Mardaryeva, N., Schiptsova, N., Lavrentyev, A., Checheneshkina, O. and Terentyeva, M. (2020). Determination of cheese suitability of milk and development of production technology of soft cheese 'Academicheskij'. In *IOP Conference Series: Earth and Environmental Science*. **604(1)**: 012032. IOP Publishing. <https://doi.org/10.1088/1755-1315/604/1/012032>.

- Lee, J.Y., Choi, J.W. and Kim, H. (2008). Determination of body surface area and formulas to estimate body surface area using the alginate method. *Journal of Physiological Anthropology*. **27(2)**: 71-82. <https://doi.org/10.2114/jpa2.27.71>.
- Marshall, M.R. (2010). Ash Analysis. In: Food Analysis, [Nelson, S. (eds)]. pp. 105-116. https://link.springer.com/chapter/10.1007/978-1-4419-1478-1_7.
- Mohamadi, Y., Lograda, T., Ramdani, M., Figuéredo, G. and Chalard, P. (2021). Chemical composition and antimicrobial activity of *Myrtus communis* essential oils from Algeria. *Biodiversitas Journal of Biological Diversity*. **22(2)**: 933-946. <https://doi.org/10.13057/biodiv/d220249>.
- Naseri, R., Arpanaei, A. and Samadi, S. (2020). Antioxidant activity of *Myrtus communis* extracts in food preservation. *Food Chemistry*.
- Nielsen, S.S. (2017). Food Analysis (5th ed.). Springer. <https://doi.org/10.1007/978-3-319-44127-6>.
- Nikmaram, N., Budaraju, S., Barba, F.J., Lorenzo, J.M., Cox, R.B., Mallikarjunan, K. and Roohinejad, S. (2018). Application of plant extracts to improve the shelf-life, nutritional and health-related properties of ready-to-eat meat products. *Meat Science*. **145**: 245-255. <https://doi.org/10.1016/j.meatsci.2018.06.031>.
- Nwafor, I.R., Alhassan, Y., Udoh, J.I., Odanibeh, D., Oyaniyi, J., Efoli-Bam, V.K., Azubuike, E.O., Ojobor, J.F.C. and Nwokafor, C.V. (2024). Plant-derived bioactive compounds and their mechanistic roles in combating microbial biofilms. *Microbiology Research Journal International*. **34(9)**: 74-85. <https://doi.org/10.9734/mrji/2024/v34i91482>.
- Raquib, M., Borpuzari, T., Hazarika, M., Laskar, S.K., Saikia, G.K. and Hazarika, R.A. (2021). The effect of packaging methods on the shelf-life of iron fortified mozzarella cheese. *Asian Journal of Dairy and Food Research*. **40(2)**: 162-166. doi: 10.18805/ajdfr.DR-1578.
- Ribas, J.C., Matumoto-Pintro, P.T., Vital, A.C.P., Saraiva, B.R., Anjo, F.A., Alves, R.L.B., Santos, N.W., Machado, E., Agostinho, B.C. and Zeoula, L.M. (2019). Influence of basil (*Ocimum basilicum* Lamiaceae) addition on functional, technological and sensorial characteristics of fresh cheeses made with organic buffalo milk. *Journal of Food Science and Technology-Mysore*. **56(12)**: 5214-5224. <https://link.springer.com/article/10.1007/s13197-019-03990-5>.
- SAS, (2012). Statistical Analysis System, User's Guide. Statistical. Version 9.1th ed. SAS. Inst. Inc. Cary. N.C. USA. <https://www.winsteps.com/al/facform.pdf>.
- Shahidi, F. and Ambigaipalan, P. (2015). Phenolics and polyphenolics in foods, beverages and spices: Antioxidant activity and health effects-A review. *Journal of Functional Foods*. **18**: 820-897. <https://doi.org/10.1016/j.jff.2015.06.018>.
- Sheet, S., Taher, Z. and Alkhashab, V. (2026). Application of active biodegradable packaging technologies using curcumin-enriched chitosan films to prolong the shelf life of soft cheese. *Asian Journal of Dairy and Food Research*. doi: 10.18805/ajdfr.DRF-630.
- Sirivella, N., Gopalakrishnan, C., Kannan, R., Pushpam, R., Uma, D., Raveendran, M. and Logeshwari, R. (2025). Analysis of bioactive secondary metabolites produced by endophytic bacillus amyloliquefaciens against rice sheath blight pathogen Rhizoctonia solani. *Agricultural Science Digest*. **45(1)**: 131-137. doi: 10.18805/ag.D-5984.
- Subramanian, A. and Rodriguez-Saona, L. (2010). Chemical and instrumental approaches to cheese analysis. *Advances in Food and Nutrition Research*. **59**: 167-213. [https://doi.org/10.1016/S1043-4526\(10\)59005-3](https://doi.org/10.1016/S1043-4526(10)59005-3).
- Yeğin, A.B., Çınar, A., Tokgöz, H., Gölükçü, M. and Ay, S.T. (2022). Phenolic composition and antioxidant activity of myrtle fruits and leaves grown in Antalya (Türkiye). *Horticultural Studies*. **39(2)**: 48-55. <https://doi.org/10.16882/hortis.1119749>.