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BIOCOLORANTS AS A FOOD ADDITIVE A SUSTAINABLE SOLUTION FOR APPLICATION IN CHEESE AND YOGURT: A REVIEW

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ABSTRACT

Natural dyes are an alternative to synthetic dyes that are widely used, mainly because the color is one of the biggest attractions of consumers when choosing products in supermarkets. And because most of the dyes used are considered harmful to health, natural dyes are the best choice, mainly because many give color and have antioxidant and antimicrobial action, in addition to having several health benefits. But often the stability of this product is insufficient. Thus, this work aims to carry out a bibliographic research on natural colorants,

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highlight the application in two different food matrices (cheeses and yogurts) and their technological application to be explored. Turmeric stood out as the natural material most used by the workers who applied it to cheeses. The stability of the dyes added to yogurts showed interesting results, since it is a product with low pH. Natural colorants generally showed a good performance and an alternative with great technological potential for food matrices.

Keywords: Bioactive compounds. Technological innovation. Biodye. Lactic products.

1 INTRODUCTION

The food industry uses various synthetic dyes such as tartrazine, quinoline yellow, sunshine yellow, azorubin, ponceaur, erythrosine, allura red, patent blue, indigo carmine, bright blue FCF, S green, bright black and HT brown, these products are increasingly being associated with various diseases and toxicity processes. Color is one of the essential aspects in the sensory perception of a food product by the consumer, psychologically influencing consumers to choose the product and provides information to assess safety and preference before consumption, increasing its acceptability and attractiveness (Singh et al., 2023). As a result, natural dyes have been growing more and more, mainly due to consumer concern about their safety and sustainability, becoming an attractive alternative that, due to their functional appeal, reduces environmental damage, and positively affects health (Mueed et al., 2024; Soutelino et al., 2024; Suzuki et al., 2017).

Some examples are described in the literature such as betalains and annatto, which have antioxidant, antihypertensive potential (Mueed et al., 2024; Soutelino et al., 2024; Suzuki et al., 2017), inhibit enzymes involved in the digestion of lipids and glucose, suggesting a potential control of obesity and blood glucose levels without showing cytotoxicity, for genipap – blue (Benvenutti et al., 2024), blue pea flower (thermal stability from 60 to 100 °C) (Vidana Gamage et al., 2023), black goji berry (thermal and storage stability at pH 3) (Gamage & Choo, 2023). Many plants contain pigments, which are responsible for their natural tones. Chlorophyll (green), carotenoids (orange, yellow), anthocyanins (red, blue, purple), and flavonoids are among these pigments (red, blue, purple) (Singh et al., 2023).

The replacement of artificial colors with natural colors is a great challenge for the industry, some are already used such as anthocyanins, betalains, and carotenoids as natural alternatives for red, orange, and yellow colors, respectively (Neves et al., 2021). One of the biggest disadvantages to natural dyes is that they have a higher price compared to synthetic dyes due to their source being native is generally very low, difficult to extract and lower stability (Mueed et al., 2024). However, instability can be improved by encapsulation systems built by various biopolymers, including proteins, polysaccharides, and compound formulations (Jiang & Zhang, 2023). Encapsulation, in addition to improving stability, is an excellent process to improve its bioaccessibility, digestibility, and controlled release (Ghosh et al., 2022; Jiang & Zhang, 2023).

Thus, the present study aimed to carry out a literature review on more recent research on biodyes and biopreservatives, highlighting the application in dairy products (cheeses and yogurts).

2 NATURAL COLORS APPLIED TO CHEESE

Table 1 highlights some studies that used natural dyes in different types of cheeses, whether the addition in capsules or even the powder of plant parts, these are some of the applications used in the studies analyzed. The most used form of application is the incorporation of the powdered material directly into the product, but processes such as extraction, encapsulation, immersion (mainly for wines) and nanoemulsion are also used.

The most used product for incorporation is turmeric, followed by parts of non-conventional plants (such as roots, leaves, flowers and seeds), which in some cases can be an alternative to reduce waste discarded by the industry.

Table 1. Addition of bioactive compounds in cheeses as a biocolor and biopreservative.

No.	Product	Incorporated	Goals	Conclusion	Authors
1	Kareish cheese with added curcumin nanoemulsion	Turmeric rhizome	Use of Kareish Cheese (Egyptian) and evaluate the stability and physicochemical parameters of curcumin nanoemulsions, evaluate their antioxidant activity and determine their antimicrobial efficacy.	The study showed that the quality of the product was maintained and the preservation period was extended using natural additives. Curcumin nanoemulsions proved to be interesting in relation to the preservation of cheese as antibacterial agents and the extension of shelf life as food additives.	(Shawir et al., 2024)
2	Cheese made from soaking in blackcurrant wine	Blackcurrant wine	Observe the effects of soaking hard cheeses and cheese slices in blackcurrant wine by evaluating their antioxidant, microbiological and sensory properties.	Blackcurrant wine has interesting characteristics in relation to the development of a new differentiated product for the market. Immersion has been shown to be effective in stopping the growth of bacteria that cause foodborne illness. The product has proven to be a valuable and viable way to improve sensory characteristics, functionality and food safety, as well as offering industries greater added value.	(Gyenge et al., 2024)
3	Ricotta cheese with added saffron	Saffron	Characterize saffron ricotta cheese through technological parameters during the production process and by evaluating the main physicochemical, microbial, sensory and antioxidant characteristics.	The product has been shown to be a suitable option for functional foods with antimicrobial properties, due to the presence of turmeric, which can contribute to extending the shelf life of the product.	(Mangione et al., 2023)
4	Curd cheese with added passion fruit	Passion fruit (*Passiflora cincinnata Mast.*)	To characterize the antimicrobial activity of passion fruit and its application in the production of curd cheese.	Passion fruit showed an interesting inhibitory potential and its potential use to control the microorganisms present in cheese. The pH and temperature showed a specific behavior, with the pH decreasing and the temperature increasing	(Costa et al., 2020)

				throughout the production process. The sensory profile showed a striking yellowish color and the presence of saffron in the aroma and flavor attributes. This application has been shown to be a suitable alternative option for functional foods and increased shelf life.	
5	Fresh sheep cheese supplemented with saffron	Saffron (*Crocus sativus* L.)	Study and produce a new sheep's cheese with saffron extract and its composition and carry out the microbiological, antioxidant and sensory characterization of the product.	Total and lactococcal bacteria counts were not differentiated in all cheeses immediately after manufacture, however a significant decrease in populations was observed in saffron cheeses during storage. Saffron proved to be efficient in relation to more intense antimicrobial activity against coliforms and enterococci. Sensory analysis showed that the slightest addition of saffron of 50 mg/L, resulted in a more sensorially accepted saffron cheese, maintaining the flavor and aroma. Turmeric is a good example of a natural dye for lactic products such as cheese that provides the product with antimicrobial and functional properties.	(Aktypis et al., 2018)
6	Semi-hard Italian cheese produced by soaking in wine	Wine	To evaluate the effect of the soaking phase on cheese characteristics and volatile compound profiles.	Cheese soaking does not influence the regular behavior of proteolysis or fermentation processes that occur during cheese ripening.	(Innocente et al., 2007)
7	Sheep's cheese with chia oil	Chia Oil (*Salvia hispanica* L.)	To evaluate the feasibility of using oil extracted from the seeds of *Salvia hispanica* L. as a source of omega-3 for 8 enrichment of sheep cheese.	The emulsified chia oil did not affect the cheese manufacturing process or normal microbial development during the maturation period and had a beneficial effect on cheese production, but it positively influenced the physicochemical parameters, also showing a stability throughout the maturation period, showing no sign of rancidity, in addition to being sensorially pleasing to consumers. The product has been shown to be a good alternative to incorporating omega-3s into dairy products, and can replace the use of animal-based oils.	(Muñoz-Tébar et al., 2019)
8	Gouda cheese with	Pepper Extract	To evaluate the physicochemical and sensory properties of	The results demonstrated that supplementing with 0.5% pepper extract microcapsules can provide	(Kim et al., 2017)

	pepper extract microcapsules	Microcapsules	Gouda cheese supplemented with pepper extract microcapsules.	additional bioactive ingredients along with maintaining the quality of Gouda cheese.	
9	Pecorino Cheese with chocolate	Chocolate Modica	Develop a new dairy product, called "chocolate cheese" and evaluate its nutritional and health properties.	With the improvement in its antioxidant properties, healthier fat, and sensory properties, chocolate cheese has the potential to be enjoyed in the market, especially by young consumers.	(Ashkezary et al., 2020)
10	Cheese with added probiotic (*lactobacillus casei*) immobilized in pieces of fruit	Apple and pear	Production of probiotic cheese using *Lactobacillus casei* cells immobilized in fruit pieces	The fruits proved to be efficient for the survival of *L. casei* cells during cheese maturation. The developed product showed a distinct taste and acceptable sensory characteristics when compared to the very popular Feta cheese. .	(Kourkoutas et al., 2006)
11	Cheese with added grape peel powders	Grape skin	Produce a cheese with grape skin powders and perform sensory analysis to characterize consumer preference	The identification of sensory properties critical to the acceptability of the product by consumers observed, which helps in the optimization of the characteristics of the fortifier and the production and composition of new cheeses.	(Torri et al., 2016)
12	Appenzeller cheese supplemented with tomato paste powder microcapsule	Tomato	To determine the physicochemical and sensory properties of Appenzeller cheese supplemented with different concentrations of powdered microcapsules of tomato extracts.	The work observed that the tomato paste powder resulted in a functional Appenzeller cheese.	(Kwak et al., 2016)
13	Gouda cheese supplemented with fruit liqueurs	Prunusmume *and* Cornus officinalis *liqueur*	To evaluate the quality characteristics of Gouda cheeses supplemented with fruit liqueur.	The product presented additional nutrients, maintaining the flavor and quality of the gouda cheese.	(Choi et al., 2015)
14	UF-Feta cheese with the addition of grape seed extract encapsulate	Siah-e-Samarghandi grape seed free	Characterization of the impact of the addition of grape seed extract and microencapsulated seed extract to UF-Feta cheese.	The product presented interesting characteristics and properties for the application of encapsulation in UF-Feta cheese.	(Sekhavatizadeh et al., 2023)
15	Gouda-type cheese with the addition of lavender	Lavender flower	Formulate a Gouda-type cheese from cow's milk, flavored with lavender flower powder and matured for 30 days and	The Gouda-type cheese had a lavender aroma. The volatile profile of the product was described as terpene and stimulated the growth of lactic acid bacteria from the initial culture. During maturation, a	(Semeniuc et al., 2=023)

	flower powder		evaluate its characteristics.	concentration of volatile compounds and lactic acid bacteria was observed, resulting in improved nutritional and textural properties. The product showed promise for commercialization.	
16	Fresh cheese with added microcapsules or nanoemulsions with *Opuntia oligacantha*	*Opuntia oligacantha*	Incorporate microcapsules or nanoemulsions with *Opuntia oligacantha into the* quality of fresh cheese and characterize it	The nanoemulsions proved to be more efficient for the antimicrobial activity, while the addition of microcapsules positively influenced the antioxidant activity.	(Pérez-Soto et al., 2021)
17	Goat cheese with the addition of rhizomes from *Gentiana lutea*	Gentiana lutea *rhizomes*	Use rhizomes of Gentiana lutea to flavour goat cheese. And evaluate the chemical and sensory properties.	The rhizomes showed results and proved to be a promising flavoring agent, contributing to the olfactory and gustatory complexity of flavored goat cheeses and the reduction of their perceptions of flavor and odor specific to goat milk products.	(Coelho et al., 2023)
18	Cow and sheep cheeses with added Saffron	Saffron	Characterize bioactive compounds from saffron in cow and sheep cheeses.	The product presented an interesting characterization in relation to the profile of bioactive compounds of cheeses made from different animals (cow and sheep) with the addition of saffron.	(Ritota et al., 2022)
19	Minas Frescal cheese with the addition of babassu mesocarp	Babassu (*Attalea speciosa*	Use of antimicrobial babassu mesocarp extract (to ensure the quality and microbial safety in Minas Fresco Cheese and reduce sodium content.	The addition of babassu coconut extract to the formulated product was not able to change the characteristics of the final product, so the term "Minas Cheese" can be used for the product obtained. The extract showed an interesting antimicrobial activity due to the presence of phenolic compounds showing to be a sustainable alternative to act as a natural antimicrobial. The work highlights an increase in texture (hardness) and color (a* and b*) parameters, which can alter the consumer's perception of color and generate a negative impact.	(Lima et al., 2024)
20	Sheep cheese with added	Moringa oleifera *leaves*	Enhance the sheep cheese type "Pecorino" by adding	The cheeses showed characteristics such as increased protein and phenolic content, improved anti-radical activity,	(Garofalo et al., 2024)

	Moringa oleifera *leaves*		*Moringa oleifera leaf powder.*	higher levels of oleic acid, reduction of secondary lipid oxidation and attractive sensory evaluation to the consumer, showing that it is an alternative for the functional food market.	
21	Cheese with added grape peel powder	Grape skin (Barbera and Chardonna)	Sensorially evaluate and optimize the enrichment of cheese with grape skin powders.	The product provides an identification of sensory properties for the acceptability of this type of product by consumers, facilitating the optimization of the characteristics of the enrichment and the production and composition of new cheeses.	I already put it before
22	Wagashi cheese with added sorghum extract	Sorghum leaf sheaths	Extract red biodye from sorghum leaf sheaths to add color to wagashi cheese, a soft cheese from West Africa.	The extraction process was sustainable and efficient for the extraction of biocolorants from sorghum leaf sheaths, with commercial ethanol as the best extraction solvent.	(Odouaro et al., 2024)
23	Cottage cheese with added encapsulated vegetable oil palm oil	Palm oil	To evaluate the bioaccessibility of microencapsulated palm oil ingredients rich in cottage cheese, its impact on sensory attributes and shelf life.	The product showed an increase in its nutritional value, in addition to an improvement in antioxidant activity, amount of vitamins and lipid profile. Its organoleptic and nutritional characteristics were highlighted, showing a good acceptance of the sensory.	(Tibaquira-Pérez et al., 2024)
24	Cheese with added pomegranate peel extract	Pomegranate peel (Punica granatum)	To evaluate the use of pomegranate peel extract as a new natural preservative in cheese.	The product is attractive and interesting as a natural preservative, improving the oxidative stability of the lipid and providing it with a longer shelf life. The bioactive compounds present in pomegranate peel extract affect the spoilage rate of products, thus improving preservation quality and can be commercially exploited as a natural preservative in cheese products.	(Mahajan et al., 2015)

3 NATURAL COLORS APPLIED TO YOGURT

Here I have to discuss using table 2, how to apply colorants in yogurts, these studies are important mainly due to the low pH characteristics of this type of product. Products with the addition of dyes (whether in powder form or natural extracts) improved the stability and concentration of bioactive compounds.

The studies found mostly used the addition of natural products in extract (9), but were also incorporated in the form of essential oil, microencapsulated and syrup. All of them sought a nutritional function due to the bioactive compounds present in the natural raw materials used.

Table 2. Yogurts with the addition of biopreservative compounds and biocolorings.

Product	Incorporated	Goals	Conclusion	Authors
Yogurt with added betacyanins from *Alternanthera brasiliana*	*Alternanthera brasiliana*	Extraction of pigments and phenolic compounds from *Alternanthera brasiliana*, application and characterization in high performance liquid chromatography and mass spectrometry.	The extract of *Alternanthera brasiliana* showed the presence of amaranthin-type betacyanins and polyphenols grouped into hydroxycinnamic acids and flavones. The extract showed stability at pH 4–11 during 21 days of cold storage. The extract obtained provided colorimetric characteristics similar to those obtained by red fruits to yogurts.	(Schneider-Teixeira et al., 2022)
Yogurt with added Mofarrah essential oil nanocapsules (*Nepeta crispa*)	Mofarrah essential oil (*Nepeta crispa*)	Nanoencapsulate the essential oil of *Nepeta crispa* and apply it to yogurt to investigate the physicochemical, microbial and sensory properties of the product.	The addition of essential oil nanocapsules resulted in a higher acidity of all yogurt samples increased during storage time and the pH decreased. The tasters demonstrated a positive evaluation for the sensory evaluation for the product added to encapsulated essential oil in taste, odor, texture and general acceptability. Nanoencapsulation also provided an increase in the shelf life of the product due to the composition of the phenolic compounds.	(Haseli et al., 2023)
Yogurt with added pomegranate extract	Pomegranate extract (*Punica granatum*)	Evaluate pomegranate extracts to control yogurt spoilage.	Yogurt with the addition of pomegranate extract is an innovative lacto-fermented beverage, differentiated by its high levels of bioactive components and various functional qualities, as well as technological qualities where the enriched yogurt had the highest levels of bioactive components and various functional qualities.	(Mueed et al., 2024)
Yogurt with added pineapple peel extract	Pineapple peel extract	To evaluate yogurts with the addition of pineapple peel extracts in relation to their post-acidification potential, physicochemical and functional qualities, aiming to achieve prolonged preservation and improve functional attributes.	The pH and acidity results indicated a significant decrease in the acidification capacity of fermented milk during refrigeration, due to microstress treatments by thermosonication and the addition of pineapple peel extracts, which resulted in a longer production time due to a slower rate of sugar fermentation and lactic acid production process. Regarding the sensory and texture evaluation, they were not affected by the addition of the extract and the total phenolic content of the yogurt increased during storage.	(Zhang et al., 2024)
Yogurt with added red pitaya betacyanins (*Hylocereus*	Red Pitaya (*Hylocereus polyrhizus*)	To evaluate the potential of a functional fruit drink with the addition of red pitaya betacyanins for use as a sustainable and stable	The results in the present study revealed that the syneresis of the embedded yogurt was able to maintain its pH, viscosity, syneresis, and viability of lactic acid bacteria without any significant change during the 8-week cold storage. The extract has been shown to be a natural,	(Lim et al., 2024)

polyrhizus)		functional liquid colorant in yogurt.	sustainable and low-cost functional ingredient that can not only impart the coloring function, but is also able to improve the stability of the physicochemical characteristics of yogurt and produce a functional yogurt with enhanced antioxidant activity.	
Yogurt enriched with cinnamon, cardamom, red cabbage and beetroot.	Cinnamon, cardamom, red cabbage, and beets.	Produce and evaluate yogurts fortified with cinnamon, cardamom, red cabbage and beets.	The final product showed significant improvements in the nutrient composition, physicochemical and sensory properties of yogurt samples enriched with extracts of cinnamon, cardamom, red cabbage and beetroot, containing bioactive compounds with significant therapeutic effects on health.	(Abdullah et al., 2023)
Yogurt with the addition of microencapsulated saffron floral residues	Saffron floral residues	Produce and characterize yogurts with the addition of microencapsulated extracts of alginate-based saffron floral by-products or/and saffron stigma extracts.	The enriched product provided protection while maintaining the antioxidant properties of the turmeric flowers in the yogurt. The microbiological profile and physicochemical parameters were not affected by the addition of turmeric extracts and resulted in a good composition of organic acids and soluble sugars that improved the shelf life of the lactic product.	(Cerdá-Bernad et al., 2023)
Yogurt with added extracts obtained from edible petals of different types of flowers	Edible flower petals (Dalia mignon, Centaurea cyanus L. and Rosa damascenas "Alexandria")	Develop yogurt using natural anthocyanin rich extracts obtained from edible petals of Dalia mignon, Centaurea cyanus L. and Rosa damascenas "Alexandria" mixed with Rosa gallica in Rosa canina. Evaluate the stability for nutritional parameters, free sugars, fatty acids, anthocyanin content and color parameter.	The yogurt showed a yellow-orange color and a nutritional enhancement, free sugars and fatty acid composition.	(Pires et al., 2018)
Yogurt with added beetroot syrup	Beetroot syrup	To evaluate the technological potential of adding different concentrations of beet syrup to yogurt on physicochemical parameters, biological activities and sensory properties and acceptance over storage time.	The beetroot syrup did not influence the pH and synergises of the product throughout the storage period and contributed to the development of an attractive red/purple color without the need to add artificial coloring, in addition to increasing the antioxidant activities, presenting a good acceptance by the tasters, facilitating its application for commercialization.	(Soutelino et al., 2023)

4 CONCLUSION

Products with the addition of natural dyes had an increase in the contraction of bioactive compounds, an interesting characteristic of natural dyes, which many have antioxidant activity. Turmeric stood out as the main material used for incorporation into cheeses. The products used in yogurts in general showed a stability in relation to the low pH characteristics of this type of product.

REFERENCES

1. Abdullah, R., Arshad, H., Kaleem, A., Iqtedar, M., Aftab, M., & Saleem, F. (2023). Assessment of angiotensin converting enzyme inhibitory activity and quality attributes of yoghurt enriched with Cinnamomum verum, Elettaria cardamomum, Beta vulgaris, and Brassica oleracea. Saudi Journal of Biological Sciences, 30(2), 103556. https://doi.org/10.1016/j.sjbs.2023.103556
2. Aktypis, A., Christodoulou, E. D., Manolopoulou, E., Georgala, A., Daferera, D., & Polysiou, M. (2018). Fresh ovine cheese supplemented with saffron (Crocus sativus L.): Impact on microbiological, physicochemical, antioxidant, color and sensory characteristics during storage. Small Ruminant Research, 167, 32–38. https://doi.org/10.1016/j.smallrumres.2018.07.016
3. Ashkezary, M. R., Bonanno, A., Todaro, M., Settanni, L., Gaglio, R., Todaro, A., Alabiso, M., Maniaci, G., Mazza, F., & Di Grigoli, A. (2020). Effects of adding solid and molten chocolate on the physicochemical, antioxidant, microbiological, and sensory properties of ewe's milk cheese. Journal of Food Science, 85(3), 556–566. https://doi.org/10.1111/1750-3841.15045
4. Benvenutti, L., Rovaris, B. C., Cesca, K., de Oliveira, D., Ribeiro, P. R. V., de Brito, E. S., & Zielinski, A. A. F. (2024). A water-based ultrasound-assisted extraction system to obtain natural blue colorant from genipap (Genipa americana L.). Food Chemistry Advances, 4, 100704. https://doi.org/10.1016/j.focha.2024.100704
5. Cerdá-Bernad, D., Valero-Cases, E., Pastor, J. J., & Frutos, M. J. (2023). Microencapsulated saffron floral waste extracts as functional ingredients for antioxidant fortification of yogurt: Stability during the storage. LWT, 184, 114976. https://doi.org/10.1016/j.lwt.2023.114976
6. Choi, H. Y., Yang, C. J., Choi, K. S., & Bae, I. (2015). Characteristics of Gouda cheese supplemented with fruit liquors. Journal of Animal Science and Technology, 57(1), 1–6. https://doi.org/10.1186/s40781-015-0048-2
7. Coelho, C., Bord, C., Fayolle, K., Bibang, C., & Flahaut, S. (2023). Development of a novel flavored goat cheese with Gentiana lutea rhizomes. Foods, 12(3), 468. https://doi.org/10.3390/foods12030468
8. Costa, C. F., Fusieger, A., Andretta, M., Camargo, A. C., Carvalho, A. F., Menezes, D. R., & Nero, L. A. (2020). Short communication: Potential use of passion fruit (Passiflora cincinnata) as a biopreservative in the production of coalho cheese, a traditional Brazilian cheese. Journal of Dairy Science, 103(4), 3082–3087. https://doi.org/10.3168/jds.2019-17791
9. Gamage, G. C. V., & Choo, W. S. (2023). Thermal and pH stability of natural anthocyanin colourant preparations from black goji berry. Food Chemistry Advances, 2, 100236. https://doi.org/10.1016/j.focha.2023.100236
10. Garofalo, G., Buzzanca, C., Ponte, M., Barbera, M., D'Amico, A., Greco, C., Mammano, M. M., Franciosi, E., Piazzese, D., Guarrasi, V., Ciulla, S., Orlando, S., Di Grigoli, A., Bonanno, A., Di Stefano, V., Settanni, L., & Gaglio, R. (2024). Comprehensive analysis of Moringa oleifera leaves' antioxidant properties in ovine cheese. Food Bioscience, 61, 104974. https://doi.org/10.1016/j.fbio.2024.104974
11. Ghosh, S., Sarkar, T., Das, A., & Chakraborty, R. (2022). Natural colorants from plant pigments and their encapsulation: An emerging window for the food industry. LWT, 153, 112527. https://doi.org/10.1016/j.lwt.2021.112527
12. Gyenge, L., Erdő, K., Albert, C., Laslo, É., & Salamon, R. V. (2024). The effects of soaking in salted blackcurrant wine on the properties of cheese. Heliyon, 10(14), e34060. https://doi.org/10.1016/j.heliyon.2024.e34060
13. Haseli, A., Pourahmad, R., Eshaghi, M. R., Rajaei, P., & Akbari-Adergani, B. (2023). Application of nanoencapsulated Mofarrah (Nepeta crispa) essential oil as a natural

preservative in yogurt drink (doogh). LWT, 186, 115256. https://doi.org/10.1016/j.lwt.2023.115256
14. Innocente, N., Biasutti, M., & Comuzzo, P. (2007). Characterization of a traditional semi-hard Italian cheese produced by soaking in wine. Food Chemistry, 105(4), 1452–1456. https://doi.org/10.1016/j.foodchem.2007.05.025
15. Jiang, M., & Zhang, Y. (2023). Biopolymer-based encapsulation of anthocyanins as reinforced natural colorants for food applications. Journal of Agriculture and Food Research, 11, 100488. https://doi.org/10.1016/j.jafr.2022.100488
16. Kim, Y. K., Nam, M. S., & Bae, H. C. (2017). Characteristics of Gouda cheese supplemented with chili pepper extract microcapsules. Korean Journal for Food Science of Animal Resources, 37(6), 833–839. https://doi.org/10.5851/kosfa.2017.37.6.833
17. Kourkoutas, Y., Bosnea, L., Taboukos, S., Baras, C., Lambrou, D., & Kanellaki, M. (2006). Probiotic cheese production using Lactobacillus casei cells immobilized on fruit pieces. Journal of Dairy Science, 89(5), 1439–1451. https://doi.org/10.3168/jds.S0022-0302(06)72212-3
18. Kwak, H. S., Chimed, C., Yoo, S. H., & Chang, Y. H. (2016). Physicochemical and sensory properties of Appenzeller cheese supplemented with powdered microcapsule of tomato extract during ripening. Food Science of Animal Resources, 36(2), 244–253. https://doi.org/10.5851/kosfa.2016.36.2.244
19. Lim, T. W., Lim, R. L. H., Pui, L. P., Tan, C. P., & Ho, C. W. (2024). Evaluating the potential of stabilised betacyanins from fermented red dragon fruit (Hylocereus polyrhizus) drink: Sustainable colouration and antioxidant enhancement of stirred yoghurt. Future Foods, 10, 100452. https://doi.org/10.1016/j.fufo.2024.100452
20. Lima, R. C., de Carvalho, A. P. A., Lelis, C. A., Faria, D. J., da Silva, B. D., da Silva de Figueiredo, M. R., Chaves, P. H. T., de Almeida, A. E. C. C., & Conte-Junior, C. A. (2024). An innovative alternative to reduce sodium in cheese: Babassu coconut byproduct improving quality and shelf-life of reduced sodium Minas fresh cheese. Innovative Food Science & Emerging Technologies, 92, 103601. https://doi.org/10.1016/j.ifset.2024.103601
21. Mahajan, D., Bhat, Z. F., & Kumar, S. (2015). Pomegranate (Punica granatum) rind extract as a novel preservative in cheese. Food Bioscience, 12, 47–53. https://doi.org/10.1016/j.fbio.2015.07.005
22. Mangione, G., Caccamo, M., Marino, V. M., Marino, G., & Licitra, G. (2023). Characterization of artisanal saffron ricotta cheese produced in Sicily: Physicochemical, microbiological, sensory, and antioxidant characteristics. Journal of Dairy Science, 106(12), 8375–8388. https://doi.org/10.3168/jds.2023-23612
23. Mueed, A., Aljahdali, S. M., Albalawi, M., Altarjami, L. R., Aljhdli, M. O., Al-Hoshani, N., AlShaqhaa, M. A., Almutairi, H. H., Alkahtani, A. M., El-Saadony, M. T., Saad, A. M., El-Tarabily, K. A., & Korma, S. A. (2024). Phenolic compounds and biological activities of berberis fruit: Enhancing role on physiochemical and antioxidant properties of yogurt. LWT, 211, 116834. https://doi.org/10.1016/j.lwt.2024.116834
24. Muñoz-Tébar, N., De la Vara, J. A., Ortiz de Elguea-Culebras, G., Cano, E. L., Molina, A., Carmona, M., & Berruga, M. I. (2019). Enrichment of sheep cheese with chia (Salvia hispanica L.) oil as a source of omega-3. LWT, 108, 407–415. https://doi.org/10.1016/j.lwt.2019.03.092
25. Neves, M. I. L., Strieder, M. M., Silva, E. K., & Meireles, M. A. A. (2021). Manufacturing natural blue colorant from genipin-crosslinked milk proteins: Does the heat treatment applied to raw milk influence the production of blue compounds? Future Foods, 4, 100059. https://doi.org/10.1016/j.fufo.2021.100059
26. Odouaro, O. B. O., Kayodé, A. P. P., Behanzin, M. S., Nout, M. J. R., & Linnemann, A. R. (2024). Extraction of dye sorghum biocolorant for the dyeing of wagashi, a West African soft cheese. Heliyon, 10(21), e39065. https://doi.org/10.1016/j.heliyon.2024.e39065

27. Pérez-Soto, E., Cenobio-Galindo, A. de J., Espino-Manzano, S. O., Franco-Fernández, M. J., Ludeña-Urquizo, F. E., Jiménez-Alvarado, R., Zepeda-Velázquez, A. P., & Campos-Montiel, R. G. (2021). The addition of microencapsulated or nanoemulsified bioactive compounds influences the antioxidant and antimicrobial activities of a fresh cheese. Molecules, 26(8), 2170. https://doi.org/10.3390/molecules26082170
28. Pires, T. C. S. P., Dias, M. I., Barros, L., Barreira, J. C. M., Santos-Buelga, C., & Ferreira, I. C. F. R. (2018). Incorporation of natural colorants obtained from edible flowers in yogurts. LWT, 97, 668–675. https://doi.org/10.1016/j.lwt.2018.08.013
29. Ritota, M., Comitato, R., & Manzi, P. (2022). Cow and ewe cheeses made with saffron: Characterization of bioactive compounds and their antiproliferative effect in cervical adenocarcinoma (HeLa) and breast cancer (MDA-MB-231) cells. Molecules, 27(6), 1995. https://doi.org/10.3390/molecules27061995
30. Schneider-Teixeira, A., Molina-García, A. D., Alvarez, I., Dello Staffolo, M., & Deladino, L. (2022). Application of betacyanins pigments from Alternanthera brasiliana as yogurt colorant. LWT, 159, 113237. https://doi.org/10.1016/j.lwt.2022.113237
31. Sekhavatizadeh, S. S., Abadariyan, N., Ebrahimi, L., & Hasanzadeh, M. (2023). Effects of free and encapsulated Siah-e-Samarghandi grape seed extract on the physicochemical, textural, microbial, and sensorial properties of UF-Feta cheese. Food Science & Nutrition, 11(7), 3923–3938. https://doi.org/10.1002/fsn3.3378
32. Semeniuc, C. A., Mandrioli, M., Tura, M., Socaci, B. S., Socaciu, M. I., Fogarasi, M., Michiu, D., Jimborean, A. M., Mureşan, V., Ionescu, S. R., Rotar, M. A., & Gallina Toschi, T. (2023). Impact of lavender flower powder as a flavoring ingredient on volatile composition and quality characteristics of Gouda-type cheese during ripening. Foods, 12(8), 1703. https://doi.org/10.3390/foods12081703
33. Shawir, S. M., Lotfy, T. M. R., Kamel, R. M., Khater, A. E., & Younes, N. M. (2024). Potential application of curcumin nanoemulsions to preserve properties of refrigerated cheese. Biocatalysis and Agricultural Biotechnology, 59, 103243. https://doi.org/10.1016/j.bcab.2024.103243
34. Singh, T., Pandey, V. K., Dash, K. K., Zanwar, S., & Singh, R. (2023). Natural bio-colorant and pigments: Sources and applications in food processing. Journal of Agriculture and Food Research, 12, 100628. https://doi.org/10.1016/j.jafr.2023.100628
35. Soutelino, M. E. M., da Silva, D. B., da Silva Rocha, R., de Oliveira, B. C. R., Esmerino, E. A., da Cruz, A. G., Márs ico, E. T., & Silva, A. C. de O. (2023). Yogurt added with beetroot extract: Physicochemical parameters, biological activities and sensory evaluation by check-all-that-apply method. International Journal of Food Science and Technology, 58(6), 3303–3309. https://doi.org/10.1111/ijfs.16214
36. Soutelino, M. E. M., Vieira, G. de P., Goulart, M. B., Miranda, K. C., da Conceição, R. P., Pimentel, T. C., da Cruz, A. G., & da Silva Rocha, R. (2024). Natural food dyes on dairy products: A critical approach between 2012–2023 literature regarding the technological and functional aspects, health benefits and future trends. Trends in Food Science & Technology, 146, 104370. https://doi.org/10.1016/j.tifs.2024.104370
37. Suzuki, M., Kimura, R., Kido, Y., Inoue, T., Moritani, T., & Nagai, N. (2017). Color of hot soup modulates postprandial satiety, thermal sensation, and body temperature in young women. Appetite, 114, 209–216. https://doi.org/10.1016/j.appet.2017.03.041
38. Tibaquira-Pérez, L., Filomena-Ambrosio, A., Bauer, K., Cardoso-Cardenas, M., Moreno, F. M., & Quintanilla-Carvajal, M. X. (2024). Validation by in-vitro digestion and sensory analysis of incorporating vegetable oil encapsulates in cottage cheese. Food Chemistry, 457, 142027. https://doi.org/10.1016/j.foodchem.2024.142027
39. Torri, L., Piochi, M., Marchiani, R., Zeppa, G., Dinnella, C., & Monteleone, E. (2016). A sensory- and consumer-based approach to optimize cheese enrichment with grape skin powders. Journal of Dairy Science, 99(1), 194–204. https://doi.org/10.3168/jds.2015-9922

40. Vidana Gamage, G. C., Goh, J. K., & Choo, W. S. (2023). Natural blue colourant preparations from blue pea flower and spirulina: A comparison stability study. Food Chemistry Advances, 3, 100457. https://doi.org/10.1016/j.focha.2023.100457
41. Zhang, X., Zheng, Y., Zhou, C., Cao, J., Zhang, Y., Wu, Z., Pan, D., Cai, Z., & Xia, Q. (2024). Combining thermosonication microstress and pineapple peel extract addition to achieve quality and post-acidification control in yogurt fermentation. Ultrasonics Sonochemistry, 105, 106857. https://doi.org/10.1016/j.ultsonch.2024.106857