ENRICHING MAYONNAISE WITH VITAMIN D_3 USING MICROCAPSULES: PRODUCT STABILITY AND QUALITY

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In modern society, the development of functional foods that not only provide the body with essential nutrients but also help prevent various diseases is of particular importance. One of the most in-demand nutrients is vitamin D_3, which plays a key role in regulating calcium-phosphorus metabolism, strengthening bone tissue, supporting immunity, and reducing the risk of chronic diseases. However, insufficient sun exposure and dietary patterns in some regions contribute to vitamin D_3 deficiency in a significant portion of the population.

Recent research in this area shows that a developed mayonnaise emulsion enriched with microencapsulated vitamin D_3 using whey and soy protein isolates has demonstrated high efficacy. Encapsulation has been shown to increase the stability and bioavailability of the vitamin, improve the microstructure and textural properties of mayonnaise, and positively impact organoleptic characteristics. In vivo experiments demonstrated a significant increase in serum vitamin D and calcium levels in animals [1].

In another study, a vitamin D_3-enriched oil-fat nanoemulsion based on rapeseed oil was developed and characterized. The authors used a combination of Tween 80 and Span 80 for stabilization, obtaining particles <200 nm in size with low PDI and stable ζ-potential. The nanoemulsions demonstrated high stability for 3 months at 25°C and 40°C, confirming the technology's potential for food fortification [2].

Mayonnaise, a widely consumed product, has a stable colloidal structure and easily digestible fats, making it a convenient matrix for enriching with biologically active substances. The use of encapsulation technology ensures the stability and preservation of vitamin D_3 throughout its shelf life and minimizes its degradation under adverse conditions.

Based on this, control (without vitamin D3) and microcapsulated vitamin D3-enriched mayonnaises with 65% fat content were produced. The recipes for these mayonnaises are presented in Table 1.

Table 1

65% fat mayonnaise recipe for industrial testing

Components	Control Sample (65% mayonnaise)	With microcapsules (5 µg/100 g)
Refined sunflower oil, %	65	65
Egg powder (emulsifier), %	2,8	2,8
Starch, %	3	2,8
Sugar, %	3	3
Salt, %	1	1
Acetic acid (70%), %	0,09	0,09
Citric acid, %	0,03	0,03
Vitamin D3 microcapsules (25 mcg/g), %	0	0,2
β-carotene, %	0,017	0,017
Flavoring, %	0,04	0,04
Potassium sorbate, %	0,06	0,06
Sodium benzoate, %	0,06	0,06
Water, %	24,91	24,91
Total, %	100,0	100,0

The resulting mayonnaise samples were tested for quality in accordance with GOST 34761–2011 "Mayonnaises and Mayonnaise Sauces. General Specifications," as well as for vitamin D3 content. The results are presented in Table 2.

Table 2

Test results of the obtained samples according to GOST 31761-2012

Indicators Norm	Control sample	Control sample	With microcapsules (5 µg/100 g)
Mass fraction of fat, %, NLT	50,0	65,1	65,1
Moisture content, %, NMT	35,0	28,4	28,5
Egg product content, calculated as dry yolk, %, NLT	1,0	2,4	2,5
Acidity, %, calculated as acetic acid, NMT	1,0	0,16	0,17
Emulsion stability, percentage of intact emulsion, NLT	98	100	100
pH	3,5-5,0	4,1	4,2
Vitamin D3 content, µg/100 g	–	–	5,0

The production of 65% fat mayonnaise begins with the preparation of the raw

materials: vegetable oil is checked for quality, egg powder is sifted and dispersed into the oil portion, and starch, sugar, salt, acids, and preservatives are pre-weighed. The aqueous phase is prepared at 20–25°C by adding salt, sugar, citric and acetic acids, and preservatives. Starch and vitamin D_3 microcapsules are then added, ensuring their complete dispersion. The fat phase is prepared separately and then gradually introduced into the aqueous phase with vigorous stirring (1000–1200 rpm), forming a stable oil-in-water emulsion. The resulting mixture is homogenized at a pressure of 12–15 MPa and a temperature of 30–35°C for 3–5 minutes, then quickly cooled to 10–12°C and maintained at 4–6°C for at least 12 hours to stabilize the structure.

Table 2 shows that both the control and test samples meet the established standard requirements. Furthermore, the test sample contains vitamin D_3, significantly increasing its biological value compared to the control sample.

Industrial trials to develop and produce mayonnaise samples fortified with microencapsulated vitamin D_3 were conducted at the pilot facilities of GOOD FOOD ORGANIC LLC. Laboratory testing, including quality control, physical and chemical parameters, and determination of vitamin D_3 content, was conducted in the accredited testing laboratory of FARMATSIYA-INNOVATSIYA MARKAZI LLC, which complies with the requirements of the international standard ISO/IEC 17025.

Thus, the results of industrial tests confirmed that fortifying mayonnaise with vitamin D_3 using microcapsules allows for a stable content of 5 μg/100 g without deviating from the standards stipulated by GOST 31761–2012. The organoleptic and physicochemical properties of the control and fortified samples were comparable, with the latter having an advantage due to its increased nutritional value due to its vitamin D_3 content.

References

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