Yevhen Dovhal
Dmytro Motornyi Tavria State
Agrotechnological University
Scientific adviser: Doctor of Technical Sciences, Olesia Priss
Language adviser: Senior Lecturer Iryna Kryvonos

THE TECHNOLOGY FOR PRODUCING CLARIFIED BUTTER (Ghee) USING VACUUM EVAPORATION

Clarified butter is a concentrated milk fat with high nutritional value, good digestibility, and enhanced stability during storage. Thanks to the almost complete removal of moisture, lactose, and protein components, the product has a long shelf life and is resistant to microbiological spoilage. The quality of clarified butter is determined by processing temperature and the method of fat-phase dehydration.

In traditional clarified butter production processes, moisture removal occurs at temperatures close to the boiling point of water (≈100°C) and above, as the fat is dehydrated under atmospheric pressure [2, 3]. This process involves intense heat exposure and results in lipid oxidation, thermal decomposition of fatty acids, and the formation of secondary oxidation products (aldehydes and ketones). When residual protein and carbohydrate components are overheated, the Maillard reaction is activated, which impairs the organoleptic properties of the product.

During prolonged heating, the concentration of secondary oxidation products may increase by a factor of 2–3, and the peroxide value may exceed 0,6 mekv O_2/kg, which is the limit value for milk fat [1]. At temperatures above 120°C, acrolein may form a toxic compound that reduces the product's safety.

An alternative approach is to use vacuum evaporation. At a reduced absolute pressure of 0.08–0.09 MPa, the boiling point of water decreases, allowing the process to be carried out at 70–90°C without excessive overheating of the fat phase [2, 3]. This enables effective moisture removal and reduces the thermal load on the product.

Lowering the temperature and limiting contact with oxygen slows down oxidative processes and the Maillard reaction, and prevents the formation of thermal decomposition products.

A comparison of the characteristics of conventional and vacuum technologies is given in Table 1.

Table 1. A Technology Comparison

Parameter	Conventional method	Vacuum evaporation method
Process temperature	≈100 °C and above	70–90 °C
Pressure	Atmospheric	0,08–0,09 MPa
Moisture removal	Slow	Intensive
Thermal impact	High	Moderate
Fat oxidation	Intense	Reduced
Formation of aldehydes and ketones	Significant	Minimal
Maillard reaction	Pronounced	Slightly pronounced
Energy consumption	Higher	Lower
Process duration	Longer	Shorter

Reducing the process temperature by 20–30°C under vacuum conditions results in lower energy consumption, shorter heat treatment times, and increased production efficiency. More intensive vacuum-based moisture removal optimizes the process and reduces heat losses [2, 3], ensuring the production of high-quality clarified butter and minimizing the formation of undesirable heat-treatment by-products.

REFERENCES

1. Food and Agriculture Organization of the United Nations & World Health Organization. (1973). *Codex standard for milkfat products (CXS 280-1973).*

2. National Institute of Food Technology Entrepreneurship and Management. (2022). Ghee write-up. https://niftem.ac.in/newsite/pmfme/wp-content/uploads/2022/08/Ghee-Writeup.pdf

3. Indira Gandhi National Open University. (2017). Unit-8: Principles and methods of manufacture of ghee and butter oil. https://egyankosh.ac.in/handle/123456789/9503