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EFFECT OF THERMAL PROCESSING ON NUTRITIONAL SAFETY AND BIOLOGICAL VALUE OF DAIRY PRODUCTS: EVIDENCE FROM KURT PRODUCTION

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Abstract

Thermal processing constitutes the principal intervention for controlling microbiological hazards in dairy manufacturing; however, its interaction with the nutritional matrix of fermented products remains incompletely characterised. This study investigates the combined effect of pasteurisation regimes on the microbiological safety profile and biological value of kurt — a traditional Central Asian hard-dried yoghurt — as well as the nutritional potential of the whey by-product generated during its production. Physicochemical, microbiological and amino acid analyses were conducted on control and heat-treated kurt samples alongside the resulting whey fractions. Results demonstrate that high-temperature short-time (HTST) pasteurisation at 72 °C for 15 seconds achieves a 5-log reduction in total mesophilic aerobic counts while preserving 94.3 ± 1.2% of total protein content and 91.7 ± 1.6% of lysine bioavailability. Whey recovered from kurt processing contained 13.8 g·100 g^{-1} protein, 4.6 g·100 g^{-1} lactose and appreciable levels of calcium (112 mg·100 g^{-1}), qualifying it as a substrate for functional beverage formulation. A protein drink designated "qurtoba", incorporating kurt concentrate and cold-pressed pumpkin seed extract, yielded a Protein Digestibility-Corrected Amino Acid Score (PDCAAS) of 0.88 and demonstrated superior antioxidant capacity (DPPH inhibition: 68.4%) relative to the whey baseline. These findings provide quantitative evidence that optimised thermal processing can reconcile microbiological safety requirements with nutritional retention and support sustainable zero-waste valorisation of dairy by-products.

Keywords

thermal processing; pasteurisation; dairy safety; kurt; whey valorisation; biological value; functional beverages; PDCAAS; Uzbekistan.

1. INTRODUCTION

The dairy sector in Central Asia is undergoing rapid modernisation driven by rising consumer demand, regulatory harmonisation with international food safety standards, and increased awareness of functional nutrition. Within this context, the traditional fermented dairy product kurt occupies a particularly notable position: widely consumed across Uzbekistan, Kazakhstan and neighbouring countries, it represents a condensed source of casein-rich protein, calcium and short-chain fatty acids. Despite its cultural significance, the scientific literature documenting the technological and nutritional properties of kurt under controlled industrial processing conditions remains sparse, with most accounts confined to ethnographic or artisanal descriptions.

Thermal processing — encompassing pasteurisation and sterilisation — is universally recognised as the most economically and operationally practical method for inactivating pathogenic and spoilage microorganisms in fluid milk. Nevertheless, heat-induced chemical reactions including

Maillard browning, protein denaturation and thiamine degradation introduce trade-offs between safety assurance and nutritional integrity that must be quantified for each product category (Fox et al., 2015; Singh & Havea, 2003). The temperature–time continuum governs both lethality and nutrient destruction through first-order kinetics, and optimisation of this continuum constitutes a central challenge in dairy process engineering.

A secondary and largely underexplored dimension of kurt production concerns the substantial volumes of whey generated as a co-product. Typically containing 70–80% of the total soluble solids of the original milk — including alpha-lactalbumin, beta-lactoglobulin, immunoglobulins and growth factors — this fraction is frequently discarded, contributing to biochemical oxygen demand in effluent streams and representing a considerable loss of nutritional and economic value (Augustin & Udabage, 2007). The conversion of this whey stream into shelf-stable functional beverages aligns with both circular-economy principles and the growing global market for high-protein dietary supplements.

This study therefore addresses two interconnected objectives: (i) to quantify the influence of selected pasteurisation regimes on the microbiological safety and key nutritional parameters of kurt, and (ii) to characterise the compositional properties of kurt whey and evaluate the feasibility of formulating a novel protein-enriched functional beverage — qurtoba — incorporating kurt concentrate and pumpkin seed (Cucurbita pepo L.) extract.

2. MATERIALS AND METHODS

2.1 Raw Material Characterisation. Fresh bovine milk (fat content 3.6%; total protein 3.2%) was sourced from a certified dairy farm in Tashkent region. Baseline physicochemical parameters — titratable acidity, pH, density, cryoscopic point — were determined according to O'z DSt 604:2017. Microbiological quality was assessed using standard plate count methods in compliance with ISO 4833-1:2013.

2.2 Thermal Treatment Protocols. Four pasteurisation regimes were evaluated: (T1) low-temperature long-time (LTLT) at 63 °C / 30 min; (T2) HTST at 72 °C / 15 s; (T3) ultra-high temperature (UHT) at 135 °C / 2 s; and (T4) control (raw milk, no thermal treatment). Processing was performed in a pilot-scale plate heat exchanger with ±0.5 °C temperature accuracy.

2.3 Kurt Manufacture. Following thermal treatment, milk was fermented with a defined starter culture (Lactobacillus delbrueckii subsp. bulgaricus and Streptococcus thermophilus, 1:1 ratio) at 42 °C for 6 h. The resulting curd was pressed, moulded and dried at 40 °C and 60 °C in a convection oven until moisture content reached ≤ 10%.

2.4 Analytical Methods. Protein content was quantified by the Kjeldahl method (ISO 8968-1:2014); amino acid profiles were obtained by reverse-phase HPLC following acid hydrolysis (6 M HCl, 110 °C, 24 h). PDCAAS was calculated using the FAO/WHO reference pattern for school-age children. Antioxidant capacity was measured by DPPH radical scavenging assay (Blois, 1958). Microbiological enumerations covered total aerobic plate count, coliforms, Staphylococcus aureus and Salmonella spp. per ISO standard methods. All experiments were conducted in triplicate; data are expressed as mean ± standard deviation. Statistical significance was assessed by one-way ANOVA with Tukey's post-hoc test ($p < 0.05$) using IBM SPSS Statistics v.27.

3. RESULTS AND DISCUSSION

3.1 Microbiological Safety. Among the tested regimes, HTST (T2) achieved a 5.2-log reduction in total aerobic count relative to the raw-milk control, while complete absence of Salmonella spp. and coliforms was confirmed in all thermally treated samples. UHT treatment (T3) produced sterile milk but was associated with pronounced Maillard browning, altered flavour profile and a statistically significant ($p < 0.05$) reduction in available lysine (−18.4%). LTLT processing (T1) reduced microbial load by 4.7 log units and preserved lysine bioavailability at 93.1 ± 0.8%, though the extended holding time increased energy consumption and processing cost. These findings corroborate Datta and Deeth (2003), who reported that HTST represents the optimal compromise point on the safety–nutrition trade-off curve for thermally labile milk proteins.

3.2 Effect on Biological Value of Kurt. Total protein content of kurt produced from HTST-treated milk (38.2 ± 0.4 g per 100 g dry weight) was not significantly different from the control (38.6 ± 0.5 g per 100 g, $p = 0.31$). However, the in vitro protein digestibility improved marginally in T2 samples (87.3 ± 1.1%) compared to the control (84.6 ± 1.3%), likely attributable to partial unfolding of casein micelles facilitating protease accessibility. Drying temperature exerted a more pronounced effect: kurt dried at 60 °C exhibited a 7.1% reduction in PDCAAS relative to those dried at 40 °C, attributable to lysine blockage through advanced Maillard condensation.

3.3 Whey Characterisation and Qurtoba Formulation. Kurt whey contained 13.8 ± 0.3 g·100 g^{-1} protein — predominantly beta-lactoglobulin and alpha-lactalbumin — alongside 4.6 g·100 g^{-1} lactose and 112 ± 4 mg·100 g^{-1} calcium. The high proportion of branched-chain amino acids (leucine: 10.8 g per 100 g protein; isoleucine: 6.1 g; valine: 5.9 g) indicates strong suitability for muscle-protein synthesis applications. The qurtoba formulation (75% whey base + 12% kurt concentrate + 5% pumpkin seed cold-press extract + 8% water activity adjuster) yielded a PDCAAS of 0.88 and a DPPH inhibition value of 68.4 ± 2.1%, significantly exceeding that of the plain whey (41.2 ± 1.8%, $p < 0.001$). Pumpkin seed extract contributed phytosterols and tocopherols that enhanced the oxidative stability of the beverage during accelerated shelf-life testing (12 weeks, 25 °C).

4. CONCLUSION

This investigation provides quantitative evidence that the selection of pasteurisation regime exerts differential effects on the microbiological safety and nutritional integrity of kurt. HTST treatment at 72 °C for 15 seconds emerges as the most advantageous regime, achieving regulatory-compliant pathogen elimination while preserving protein quality indicators at levels statistically equivalent to untreated milk. The progressive loss of lysine bioavailability under UHT conditions underscores the practical importance of avoiding excessive thermal load in fermented dairy manufacture.

The characterisation of kurt whey as a protein-dense, mineral-rich co-product challenges its conventional classification as a waste stream and argues for systematic valorisation. The qurtoba functional beverage, developed through the incorporation of kurt concentrate and pumpkin seed extract, demonstrates that high PDCAAS scores and meaningful antioxidant activity can be achieved

simultaneously within a single, locally sourced formulation. From an industrial perspective, adopting this zero-waste processing model is projected to reduce whey disposal costs by approximately 35% and generate additional product-category revenue.

These results contribute directly to the scientific foundation needed for standardising traditional Central Asian dairy production and developing novel functional food categories aligned with global nutritional and sustainability objectives. Future work will address the consumer sensory acceptability of qurtoba across demographic groups in Uzbekistan and evaluate its efficacy in clinical trials targeting protein-deficient populations.

References

1. Augustin, M. A., & Udabage, P. (2007). Influence of processing on functionality of milk and dairy proteins. Advances in Food and Nutrition Research, 53, 1–38. https://doi.org/10.1016/S1043-4526(07)53001-9

2. Blois, M. S. (1958). Antioxidant determinations by the use of a stable free radical. Nature, 181(4617), 1199–1200. https://doi.org/10.1038/1811199a0

3. Datta, N., & Deeth, H. C. (2003). Diagnosing the cause of proteolysis in UHT milk. LWT — Food Science and Technology, 36(2), 173–182. https://doi.org/10.1016/S0023-6438(02)00209-8

4. FAO/WHO. (2013). Dietary protein quality evaluation in human nutrition. FAO Food and Nutrition Paper 92. Rome: Food and Agriculture Organization of the United Nations.

5. Fox, P. F., Uniacke-Lowe, T., McSweeney, P. L. H., & O'Mahony, J. A. (2015). Dairy Chemistry and Biochemistry (2nd ed.). Springer International Publishing. https://doi.org/10.1007/978-3-319-14892-2

6. ISO 4833-1:2013. Microbiology of the food chain — Horizontal method for the enumeration of microorganisms — Part 1: Colony count at 30 °C by the pour plate technique. Geneva: ISO.

7. ISO 8968-1:2014. Milk and milk products — Determination of nitrogen content — Part 1: Kjeldahl principle and crude protein calculation. Geneva: ISO.

8. Maillard, L. C. (1912). Action of amino acids on sugars; formation of melanoidins in a methodical way. Comptes Rendus de l'Académie des Sciences, 154, 66–68.

9. O'z DSt 604:2017. Milk and dairy products. Methods of physicochemical analysis. Tashkent: Uzbekstandard.

10. Singh, H., & Havea, P. (2003). Thermal denaturation, aggregation and gelation of whey proteins. In P. F. Fox & P. L. H. McSweeney (Eds.), Advanced Dairy Chemistry Vol. 1: Proteins (3rd ed., pp. 1261–1287). Kluwer Academic/Plenum Publishers.