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INNOVATIVE BREAD RECIPES WITH PLANT PROTEINS (CHICKPEAS AND LENTILS) IN THE CONTEXT OF CURRENT HEALTHY EATING TRENDS

Summary. *The article systematizes the regulatory framework governing the quality and safety of bakery products for preschool and school educational institutions. Based on the author's production experience, the most vulnerable points in the technological process, where deviations from standards most often occur, are identified, and practical means of eliminating them in small enterprises are described. The author's approach to enriching bread with vegetable proteins is characterized: adding a mixture of chickpea and lentil flour in an amount of 8–12% of the flour mass increases the calculated protein content of the flour mixture by approximately 8–12% compared to pure wheat flour, improves the mineral composition of the product, and does not impair its organoleptic characteristics. The key technological advantage of this approach is the combination of legume flour with controlled fermentation in the clean-label concept (pure composition without synthetic improvers), where structure stabilization is achieved exclusively by natural means. Recommendations have been formulated for the preparation of technical documentation for participation in tender purchases for educational institutions.*

Key words: *bakery products, baby food, food safety, HACCP, vegetable protein, chickpea flour, lentil flour, functional bread, clean label.*

Introduction. Bread appears daily on the tables of kindergartens and schools throughout Ukraine and is the main source of complex carbohydrates, dietary fiber, and minerals for most children. Despite the everyday nature of the product, bakery products for educational institutions are subject to strict regulatory control, and their production poses specific technical challenges. A significant portion of this bread comes from small regional producers, and it is they who, based on the author's production observations, most commonly show deviations from requirements: elevated salt content, insufficient microbiological control, and incomplete HACCP records [1; 2]. The reason is rarely dishonesty - more often than not, the producer simply does not have a systematic understanding of what parameters to adhere to and how to do so with limited laboratory facilities.

Chickpea flour contains about 22 g of protein and 5–10 g of dietary fiber per 100 g; lentil flour contains about 26 g of protein and 11–12 g of dietary fiber per 100 g; for comparison, wheat bread flour contains about 12 g of protein and only 2–3 g of fiber per 100 g [13]. This difference in composition is the physical basis for enriching bakery products with legume flour. At the same time, market demand is growing: according to Grand View Research, the global market for high-protein bakery products was worth about $4.5 billion in 2024 and is projected to grow at a rate of 7% annually until 2030, with the bread segment accounting for 53% of this market [14]. Enriching bread with plant proteins from chickpeas and lentils is a technologically sound response to this demand: legumes have a favorable amino acid profile, combine well with wheat flour, and do not require a radical re-equipment of production [3; 4].

The purpose of this article is to systematize the current regulatory requirements for bread for children, identify the most common points of violation

in production, and describe the author's technological approach to enriching recipes with vegetable protein.

Literature review. Regulating the quality of bread for children lies at the intersection of technological law and food safety. The school meal reform, enshrined in Resolution No. 305 of the Cabinet of Ministers of Ukraine (CMU) dated March 24, 2021 [5], has significantly updated the requirements for the range and composition of products: sweeteners, synthetic colors and flavors, flavor and aroma enhancers are prohibited, and the standards have been brought into line with the physiological needs approved by the Ministry of Health (MOH) of Ukraine. At the same time, the current industry standards still lack a separate category of products with a high vegetable protein content, which complicates the regulatory identification of functional bread in tender purchases.

A key foreign publication on chickpeas as a baking ingredient is a review article by Grasso N., Lynch N. L., Arendt E. K., and O'Mahony J. A. (2022) in Comprehensive Reviews in Food Science and Food Safety. The authors described in detail the composition of chickpea proteins (21–24% protein, 5–10% dietary fiber, 4–5 mg iron per 100 g), demonstrated a wide range of their water-binding and gel-forming properties, and technological compatibility with grain recipes at moderate doses [6]. Aider M., Sirois-Gosselin M., and Boye J. I. (2012) directly investigated the effect of pea, lentil, and chickpea protein concentrates on bread quality at 3%, 6%, and 9% replacement of wheat flour. It was found that chickpea protein at 6–9% gives the best specific volume values among all legumes studied (3.72–3.84 ml/g), while lentil and pea protein at the same doses give lower volume values [7]. This explains the technological logic behind the author's decision: chickpeas are the basic component with the best structure-forming properties, while lentils are an additional source of protein and minerals.

Rizzello C. G. et al. (2014) in the International Journal of Food Microbiology studied a mixture of wheat, chickpea, lentil, and legume flour with a first-type starter culture and found that fermentation increased phytase activity,

antioxidant activity of the product, and reduced the glycemic index compared to the control without starter culture [8]. It is this mechanism that underlies the author's approach Korniienko A.

Materials and methods. The regulatory framework for the study consisted of: Law of Ukraine "On the Basic Principles and Requirements for Food Safety and Quality" dated 23.12.1997 No. 771/97-VR; Law of Ukraine "On State Control over Compliance with Food Legislation" dated May 18, 2017, No. 2042-VIII ; Resolution of the Cabinet of Ministers of Ukraine dated March 24, 2021, No. 305 (as amended on October 8, 2025, No. 1280); State Standard of Ukraine (DSTU) 7517:2014 "Bread made from wheat flour. General technical conditions". The composition of raw materials was determined based on the USDA FoodData Central database. The nutritional value of the enriched flour mixture was calculated using the proportional method. The practical part is based on the author's production experience.

Research results

Regulatory framework: what is actually mandatory for manufacturers

Manufacturers supplying bread to children's institutions are subject to a multi-level regulatory framework. The first is Law No. 771/97-VR, which requires all market operators to implement HACCP. Failure to comply with this obligation is punishable by a fine under Article 65 of Law No. 2042-VIII: 30 minimum wages for legal entities and 15 minimum wages for individual entrepreneurs (FOP), as well as suspension of operations [1, 9]. The second level comprises current MOH regulations on children's nutrition (e.g., MOH Order No. 1084) and sanitary regulations for educational institutions (MOH Orders No. 234 and No. 2205), which set stricter limits on pesticide, mycotoxin, and heavy metal residues [10].

Specific physical and chemical parameters are defined by DSTU 7517:2024: moisture content - no more than 48.0%, acidity - no more than 3.5 degrees, crumb porosity - no less than 72% [11]. Microbiological safety is

regulated by MOH Order No. 548 (as amended); the following values are indicative of enterprise-level laboratory specifications for wheat bread: total microbial count not more than 1×10^3 CFU/g, yeast and not more than 1×10^2 CFU/g, coliform bacteria (BGKP) not permitted in 1 g. The applicable annex/category of Order No. 548 for bakery products should be verified and cited.

Resolution of the Cabinet of Ministers of Ukraine No. 305 of 24.03.2021 is a key document on the organization of nutrition in educational institutions [5]. It regulates the nutritional value of the diet in accordance with the standards of the Ministry of Health and directly prohibits sweeteners, synthetic colors and flavors, and flavor and aroma enhancers. For the manufacturer, this means that the clean-label concept is not a marketing ploy, but a regulatory requirement. Chickpea and lentil flour are ingredients listed among the allergens in Annex 1 of Law No. 2639-VIII; they must be clearly highlighted in the ingredient list on the label.

HACCP in small businesses: where violations most often occur

HACCP has been mandatory for small food industry facilities since September 20, 2019 [1]. In small bakeries, limited staff, job sharing, and the lack of their own laboratory often lead to HACCP existing only "on paper." Practical experience reveals five points where quality most often exceeds regulatory limits.

Flour reception remains the least controlled point: flour is the main carrier of mycotoxins and metal magnetic impurities, and if the enterprise does not require quality certificates from the supplier and does not carry out incoming control, the risk of dangerous raw materials entering the production process remains unmanageable. Dough mixing requires water temperature control: above 40°C, undesirable microorganisms are activated and the gluten structure is destroyed. During proofing, the critical parameters are a temperature of 36±2°C and a relative humidity of 75±5%; deviations result in either underproofed dense bread or excessive acid accumulation. Baking is the only guaranteed microbiological barrier: the temperature in the center of the bread must reach at

least 96°C [2]. Cooling and packaging are the most vulnerable points in terms of secondary contamination - warm bread condenses moisture, and the hands of staff or packaging materials become a source of contamination; bread is packaged after the temperature has dropped to 35°C.

The most common mistakes made by manufacturers and ways to fix them

Production experience reveals three persistent categories of violations. Excess salt is the most common reason for a product's non-compliance with preschool nutrition requirements [5; 11]; control measure: weighing salt on electronic scales at each kneading and monthly verification of salt content using an electrical conductivity (conductometric) method. Unstable moisture content arises due to variations in flour moisture content between batches, inconsistent dough hydration, or deviations in the baking mode; regular weighing of products after cooling and comparison with standard indicators allows deviations to be detected in a timely manner; in winter and summer, the recipe often has to be adjusted. Rope spoilage, caused by the bacterium Bacillus subtilis, occurs mainly in summer when stored above 25°C: the crumb becomes sticky and develops a specific odor. Prevention involves maintaining the acidity of the dough at a pH of 4.5–5.0, using sourdough or lactic acid cultures, and maintaining a strict temperature chain from the bread's exit to the consumer [12].

Table 1

Root Cause Analysis of Typical Violations

Violation	Immediate Cause	Systemic Cause	Detection Method	Preventive Strategy
Excess salt	Overdosing during mixing	Lack of scale calibration	Conductivity test	Electronic weighing + monthly verification
Unstable moisture	Variable flour hydration	No seasonal correction	Post-cooling weighing	Recipe adjustment (winter/summer)
Rope spoilage	High storage temperature	Weak acidity control	Sensory + pH control	Maintain pH 4.5–5.0; sourdough use

Author's technology for enriching bread with chickpea and lentil flour

Chickpea flour contains about 22 g of protein, 5–10 g of dietary fiber, 4–5 mg of iron, and a significant amount of magnesium and potassium per 100 g; lentil flour contains about 26 g of protein and 11–12 g of dietary fiber per 100 g. For comparison, wheat bread flour contains about 12 g of protein and only 2–3 g of dietary fiber per 100 g [13]. This difference is the basis for enrichment.

The author's recipe by Korniienko A., developed in real baking conditions, involves adding a mixture of chickpea and lentil flour within 5–15% of the flour weight, with the optimal range being 8–12% - a balance between functionality and structure quality. Within the range of 8–12%, the dough rise remains stable; at higher doses, the gluten structure weakens noticeably, the crumb becomes denser, and the volume of bread decreases [7]. The combination of two types of legume flour, rather than one, provides a more balanced amino acid profile and milder specific legume notes.

According to calculations based on USDA FoodData Central data, adding 8–12% of a mixture of chickpea and lentil flour (in equal proportions) increases the estimated protein content of the flour mixture by approximately 8–12% compared to pure wheat flour - from ~12.0 g to ~13.0–13.5 g per 100 g of mixture [13]. Along with protein, the content of iron, magnesium, potassium, and dietary fiber increases; the calorie content changes insignificantly. The exact value of the increase in the finished product depends on the recipe balance and requires laboratory confirmation.

The addition of legume flour changes the technological parameters: legume protein and fiber increase the water absorption of the dough, so hydration is adjusted according to the specific batch of flour and season, kneading is prolonged, and the acidity of the dough is controlled more carefully [6; 7]. If necessary, proofing is also prolonged. Sourdough, autolysis, malt, natural enzyme systems, psyllium, or seeds can be used to stabilize the structure and taste. Sourdough or autolysis are preferred: fermentation increases phytase activity and

improves the digestibility of minerals, as confirmed in a study by Rizzello et al. [8].

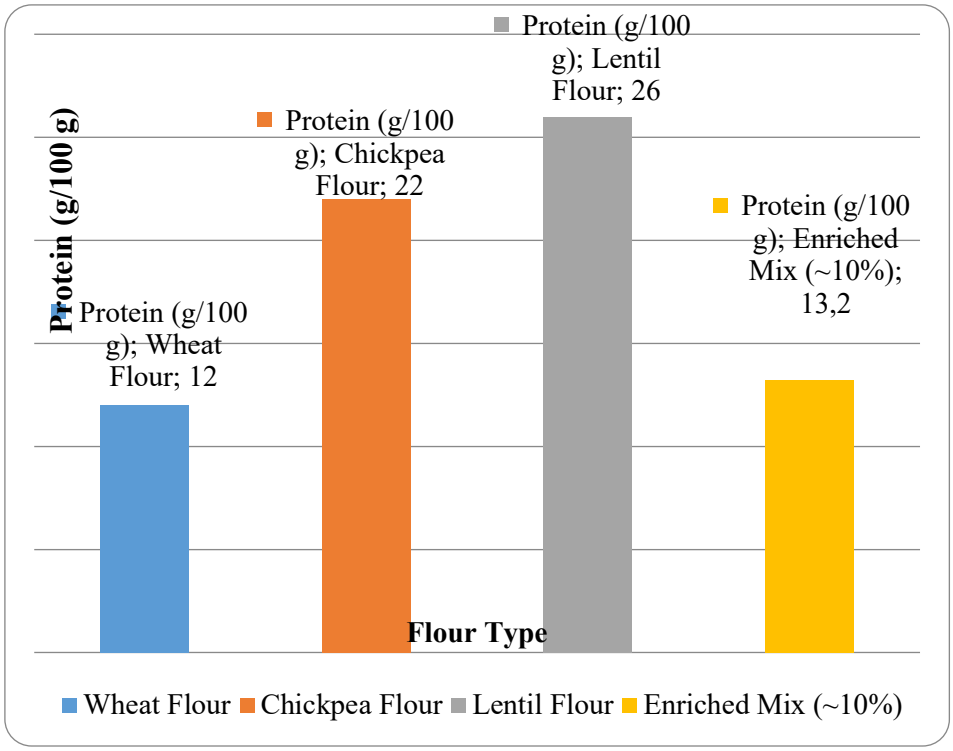

Fig. 1. Protein Content Comparison of Wheat Flour, Chickpea Flour, Lentil Flour, and the 10% Enriched Blend (g per 100 g)

Organoleptically enriched bread acquires light nutty and legume notes, which most consumers perceive positively. According to the author's production observations, there is a high level of repeat purchases and growing interest in the product - these observations are subjective and require formalized organoleptic evaluation or consumer surveys for scientific verification. The color of the crust becomes darker, acquiring a warm cream-beige hue and an artisanal appearance due to the Maillard reaction. The texture of the crumb becomes slightly denser with finer porosity, but at the same time, its moisture and juiciness improve. The shelf life is not reduced - the increased moisture retention capacity of legume flour slightly prolongs the natural freshness of the product.

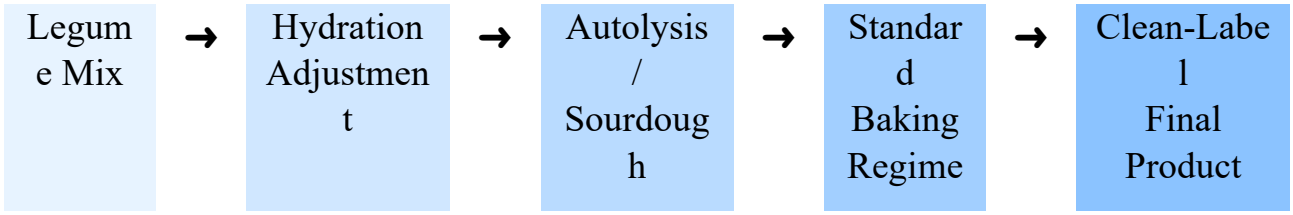

Fig. 2. Integrated Clean-Label Production Model

The unique technological advantage of the author's approach is the combination of legume flour, controlled fermentation, and the clean-label concept: the structure is stabilized by natural means without synthetic improvers, which meets the requirements of CMU Resolution No. 305 [5].

Table 2

Functional and Market Advantages of the Author's Technology

Component	Technological Function	Nutritional Benefit	Market Value
Chickpea Flour	Supports structure at moderate dose	Protein + iron source	Clean-label enrichment
Lentil Flour	Enhances amino acid profile	High fiber	Healthy lifestyle segment
Controlled Fermentation	Improves mineral bioavailability	Better digestibility	Artisanal positioning
Clean-Label Concept	No synthetic improvers	Consumer trust	Compliance with CMU 305

The technology is suitable for serial and industrial production with proper process control - this approach is scalable for manufacturers working with tender supply volumes. The bread is suitable for nutrition-conscious consumers, athletes, young families, and healthy lifestyle enthusiasts. Individual tolerance should be taken into account: chickpea and lentil flour are allergens under Annex 1 of Law No. 2639-VIII and must be highlighted in the labelling. For the legal positioning of a product with a high protein content, laboratory confirmation in an accredited laboratory and the development of technical specifications (TS) or voluntary certification are required.

Discussion of results. The practical results are consistent with international studies. Grasso et al. (2022) confirm that chickpea protein is the most technologically compatible among legumes with grain systems due to its water-binding and gel-forming properties [6]. Aider et al. (2012) found that 6–9% chickpea protein concentrate gives the highest specific volume among the legumes studied, while lentil and pea protein at the same doses give lower values [7] - this confirms the feasibility of a chickpea-centric recipe with lentils as a secondary component. Rizzello et al. (2014) showed that sourdough unlocks the nutritional potential of wheat-legume mixtures without compromising taste and texture [8].

An important difference between the laboratory and actual production is that flour quality varies between batches, and temperature and humidity fluctuate seasonally. Therefore, the recommendations in this article focus on simple control methods - pH measurement, thermometry, weighing - without the need for complex equipment.

Regulatory aspect: current DSTU standards for bread do not distinguish a category of products with a high vegetable protein content. A manufacturer wishing to legally position such a product for educational institutions must develop technical specifications or undergo voluntary certification confirming the nutritional value in an accredited laboratory. This is both a legal requirement and a competitive advantage in tenders.

Limitations of the work: the practical part is based on the experience of one enterprise and does not contain formalized organoleptic or laboratory measurements of the finished product. Further research should include standardized tasting evaluation, instrumental measurement of structural parameters, and verification of nutritional value in an accredited laboratory.

Conclusions. The manufacturer of bakery products for children's institutions operates within the regulatory framework established by Law No. 771/97-VR (HACCP), Law No. 2042-VIII (sanctions), CMU Resolution No.

305/2021 (organization of nutrition in educational institutions), and DSTU 7517:2024 (technical conditions for wheat bread). Ignorance of specific requirements leads either to a lost tender or to a real risk to children's health.

The most vulnerable points in the technological process are cooling and packaging. Real protection is provided not by the availability of HACCP documentation, but by the regularity of recording measurements and the rapid processing of deviations.

Chickpea flour contains about 22 g/100 g of protein, lentil flour - about 26 g/100 g, which significantly exceeds the indicator for wheat bread flour (~12 g/100 g) [13]. Adding a mixture of these components in an amount of 8–12% of the flour mass increases the calculated protein content of the flour mixture by approximately 8–12%, improves the mineral and fiber profile of the product, does not impair the organoleptic characteristics, and improves the moisture and juiciness of the crumb; The exact value of the increase in the finished bread requires laboratory confirmation. The combination of legume flour, controlled fermentation, and the clean-label concept meets the requirements of CMU Resolution No. 305 and the growing market demand for functional bakery products [14]. The technology is suitable for mass production; technical conditions and laboratory confirmation of nutritional value are required for the legal positioning of the manufacturer.

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