CASE STUDY

Topic: **Effect of Pea Protein and Quinoa Addition on Bioactive Compounds in Fermented Chicken Salami**

Team №… **02**

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I. Executive Summary (150 words)

This study explores the development of an innovative fermented chicken salami enriched with pea protein and quinoa. The product is a hybrid fermented meat product or sometimes called dual protein,combining animal and plant proteins to meet the growing consumer demand for high-protein, clean-label, and functional foods.

The innovation lies in the use of pea protein and quinoa, which not only improves the product's amino acid profile but also contributes to antioxidant activity and improved texture. The development was driven by increasing health consciousness, the need for sustainable protein sources, and the popularity of flexitarian diets. Some studies demonstrated that the addition of these ingredients enhanced the nutritional quality and bioactivity of the final product without compromising sensory attributes. This study aims to create a healthier alternative to traditional meat products by incorporating plant-based ingredients rich in bioactive compounds, such as polyphenols, flavonoids, and dietary fiber.

II. Introduction (300 words)

Consumer demand for healthier, functional meat products has been rising due to increased awareness of the relationship between diet and chronic diseases such as cardiovascular conditions, obesity, and diabetes. The demand for processed meat products shows good growth. In China, it was doubled by 2009 (Zhou et al., 2012) and by 2017 18% of fresh meat was being diverted to products (Liu et al., 2017). Traditional fermented meat products like salami are appreciated for their sensory properties and shelf-life but are often criticized for high fat and sodium content and low functional value (Munekata, Paulo ES, et al., 2022). To address these concerns, the incorporation of plant-based ingredients with proven nutritional and bioactive properties has gained momentum in meat product development.

Pea and quinoa are two such plant-derived ingredients. Pea protein is a rich source of essential amino acids, especially lysine, and exhibits high digestibility and antioxidant activity (Lu, et al., 2020). Quinoa (Chenopodium quinoa Willd.) is a pseudocereal known for its balanced amino acid profile, dietary fiber, phenolic compounds, and minerals (Nowak et al., 2016). Their addition to meat matrices offers the dual benefit of improving nutritional content and enhancing the presence of bioactive compounds such as antioxidant peptides and phenolics.

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This study aims to develop an innovative healthier vegan meat product which includes both animal meat and plant protein. In our product development, chicken is selected as the primary meat source due to its favorable nutritional profile and broad consumer acceptance. Compared to other meat types, white meat, particularly chicken, is considered a healthier option owing to its high-quality protein content, beneficial fat composition, and lower levels of harmful cholesterol and low-density lipoprotein (LDL) (Kubbaa et al., 2023). Additionally, chicken is widely available, no religious restrictions, cost-effective, and efficient to produce, making it a practical and sustainable choice for functional food applications. These attributes collectively position chicken as a preferred alternative to red meat. Additionally, our study also evaluates changes in antioxidant activity, total phenolic content, and potential formation of bioactive peptides resulting from fermentation.

The target consumers are health-conscious individuals, including flexitarians, athletes, and those adhering to high-protein or functional diets. Additionally, with the global rise in plant-forward eating habits, this product aligns with consumer trends favoring clean-label and protein-enriched alternatives without fully eliminating animal-based components (Ismail et al., 2020).

III. Market Analysis: (300 words)

Interest in alternative protein sources to substitute for animal source protein-rich foods has emerged alongside calls for sustainable food systems. With the global population projected to reach 9.8 billion by 2050, sustainable diets call for reduced animal meat intake and shift the diets towards a diversity of nutrient-dense plant-based foods (Clark et al., 2019, Willett et al., 2019). The target market for fermented chicken salami with pea protein and quinoa includes health-conscious individuals, flexitarians, and protein-focused consumers aged 20–50. These consumers seek high-protein, low-fat, and nutrient-enriched alternatives that do not compromise taste or texture. The inclusion of plant-based ingredients appeals especially to those interested in gut health, muscle recovery, and antioxidant-rich diets.

Recent trends show a growing preference for hybrid meat products, which blend animal and plant proteins to enhance nutritional quality while reducing environmental impact. According to a 2023 Euromonitor report, the hybrid meat segment is projected to grow at CAGR (Compounded Annual Growth Rate)of 7.5% through 2028. Products combining chicken with plant-based ingredients, like pea protein and ancient grains such as quinoa, cater to consumers seeking natural sources of bioactive compounds like polyphenols, peptides, and dietary fiber.

Competition exists from traditional salami producers and emerging hybrid protein brands. Direct comparisons indicate that insects are the least accepted alternative protein, cultured meat the second-

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least, and that plant-based meat substitutes are among the most accepted alternative proteins (Circus & Robinson, 2019; Grasso et al., 2019; Ianuzzi, 2019). However, few products in the current market integrate both pea protein and quinoa into fermented poultry meats. This creates a niche opportunity for innovation.

In comparison to traditional chicken salami, the proposed product offers improved functional properties, enhanced nutritional profile, and reduced allergenic concerns. These advantages provide strong differentiation in a competitive market that increasingly values health, sustainability, and innovation in meat product development.

IV. Research and Development: (500 words)

The development process began with a thorough review of prior studies on hybrid meat products enriched with plant-based ingredients. Pea protein is recognized for its balanced amino acid profile and antioxidant peptides formed during proteolysis. Quinoa is rich in dietary fiber, essential amino acids, and polyphenols with strong antioxidant activity. Based on successful applications in products like quinoa-enriched chicken sausages (Poursalehi et al., 2021) and hybrid meat burgers from lentils and Pea (Peñaranda et al., 2023), combinations of 5–10% pea protein and 3–7% quinoa flour will be tested in chicken salami formulations.

Controlled fermentation will be carried out using *Lactobacillus sakei* or, a strain well-documented for improving peptide profiles and antioxidant activity in meat fermentation (Pereira et al., 2020). Key fermentation parameters (such as pH, water activity, and microbial stability) will be monitored, along with the evaluation of bioactivity using DPPH (2,2-diphenyl-1-picrylhydrazyl) and ABTS (2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)) radical scavenging assays, and total phenolic content via the Folin–Ciocalteu method.

Preliminary focus groups (n=10 to 15) will be conducted to evaluate consumer attitudes toward hybrid meat products and expectations regarding taste and labeling (e.g., “high-protein,” or “clean-label”). Based on this feedback, flavor-masking strategies using spices such as garlic and paprika will be optimized. Later, a sensory evaluation involving 30–40 untrained consumers will be conducted using a 9-point hedonic scale to assess acceptability in terms of taste, texture, appearance, and overall preference. A formulation showing high functional enhancement without compromising sensory quality will be selected for in-depth biochemical analysis.

The base recipe will include chicken meat, pea protein isolate, pre-cooked quinoa flour, curing salt, glucose, selected spices, and a starter culture. After mixing, the blend will be vacuum-filled into collagen

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casings and fermented at 24 ± 1 °C with 85–90% humidity. Texture profile analysis (TPA), water-holding capacity, and color (L*, a*, b*) will be evaluated and will be compared with the consumer acceptability evaluation. In a previous study on sausages, the fiber and starch content of quinoa were shown to contribute to improved oxidative stability, indicating its potential to enhance product quality and extend shelf life (Dautova, Assel, et al., 2024). Peptides will be extracted according to the method of Zhu et al. (2013) with slight modifications. Peptide antioxidant activity will be measured in terms of ABTS and DPPH radical scavenging activity and ferric-reducing antioxidant power (reducing power). The contents of free amino acids will be determined. Other parameters will be studied like L- carnitine, glutathione etc. Statistical analysis will be done using ANOVA or similar tests.

The incorporation of plant-based ingredients contributes to nutritional enrichment and sustainability by reducing animal protein content. The antioxidant activity of peptides in meat products is very important because of their natural potential to influence human health as well as their positive effect on food quality, such as inhibition of oxidative reactions, which increases the shelf life of products (Lorenzo et al., 2018). The formulation will be free from synthetic additives, supporting clean-label claims. To promote zero-waste innovation, quinoa bran (a milling by-product) may be tested as a natural fiber enhancer, contributing to circular food system goals.

V. Product Description: (500 words)

Our developed product will be fermented chicken salami; enriched with pea protein and quinoa. This innovation targets health-conscious consumers seeking high-protein, alternative but sustainable protein sources, low-fat, and bioactive-rich alternatives without compromising taste and texture. The manufacturing process flow chart, slightly adapted from Shin, Dong-Jin, et al., 2022 could be as follow:

Chicken Meat ➔ Grinding (5 mm) ➔ Addition of salt, phosphate, pea protein, quinoa , ½ iced water ➔ Addition of sunflower oil ➔ Mixing and Stuffing ➔ Fermentation with bacteria culture at 25℃ ➔Drying at 15℃ ➔Fermented Chicken Salami

The base of the product is lean chicken meat, selected for its low saturated fat content compared to red meats. The formulation might include 10% pea protein and 5% quinoa, incorporated pre-fermentation. Controlled lactic acid fermentation using selected starter cultures (e.g., *Lactobacillus sakei* or *Pediococcus pentosaceus*) enhances the release of bioactive peptides. Pea protein (*Pisum sativum*) contributes essential amino acids, mainly lysine, and is rich in bioactive peptides that can exhibit antioxidant and antihypertensive properties upon enzymatic breakdown during fermentation. Quinoa flour (*Chenopodium quinoa*) adds fiber, essential minerals (magnesium, iron), and phenolic compounds

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known to enhance antioxidant capacity. Fermentation also improves the bioavailability of minerals and stabilizes phenolic compounds present in quinoa. Other ingredients such as spices and salt will be used to complete the formulation.

Estimated nutritional values per 100 g:

- **Protein**: 24–26 g
- **Fat**: 2–4g
- **Dietary Fiber**: 2–3 g
- **Energy**: ~180–200 kcal

Unique Selling Proposition (USP)

- Provides enhanced health functionality (e.g., antioxidant properties)
- Contains clean-label, plant-based ingredients
- Meets the needs of today's consumers
- Maintains traditional sensory appeal while boosting nutritional value
- Low in saturated fats and cholesterol
- Free from common allergens like soy or dairy
- Incorporates sustainable plant proteins, positioning it uniquely in the growing market for functional and hybrid meat products
- Replace around 30% of animal meat or red meat consumption

Innovation and Market Differentiation

Fermented chicken Salami supplemented with peas and quinoa exemplifies a functional meat innovation through:

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- Enhancement of bioactive compounds via fermentation
- Strategic inclusion of plant-based ingredients that synergize with microbial activity. Pea protein contributes lysine-rich peptides and supports protein complementation with cereal proteins.
- The use of quinoa in fermented meat matrices is uncommon, making this formulation distinct and innovative. Its inclusion not only enhances the nutritional profile but also aligns with consumer demand for grain fortification in processed products. Furthermore, replacing traditional fat sources with plant proteins supports fat reduction strategies without compromising texture, thanks to emulsion-stabilizing properties of legume proteins.
- Both pea and quinoa are low-impact crops, supporting eco-friendly production.

The hybrid formulation therefore satisfies multiple people looking for more sustainable alternatives:

- Flexitarians who are seeking reduced meat, nutrient-enhanced options
- Health-focused consumers demanding cleaner labels and functional benefits
- Traditional buyers looking for authentic fermented meat taste and flavor

In contrast to plant-only meat analogs, this formulation preserves authentic meat texture and flavor. While, it addresses growing concerns related to processed red meats, such as high nitrite content and saturated fat intake, which have been linked to colorectal cancer and cardiovascular disease (Bouvard et al., 2015; WHO, IARC Monographs, 2015). By leveraging protein complementation and fermentation, the product appeals to both health-conscious and traditional consumers. It helps to bridge the market gap in premium deli and wellness food markets.

VI. Marketing and Promotion: (300 words)

To successfully launch the innovative product “Fermented Meat Products from Chicken with Pea Protein and Quinoa”, the marketing strategy will focus on positioning it as a healthy, sustainable, and modern alternative in the meat product market. Considering current consumption trends, the product targets people seeking a balanced lifestyle, athletes, flexitarians, and environmentally conscious consumers.

The brand will convey innovation, nutritional balance, and environmental responsibility. The packaging will be eco-friendly and recyclable, with a minimalist design that highlights the key ingredients and the fermentation process. The labeling will include clear nutritional information and claims such as “no artificial additives”, “source of plant-based protein”, and “naturally fermented”.

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The pricing strategy will be accessible, yet slightly premium to reflect the product's quality. Distribution channels will include supermarkets, health food stores, online platforms, and the HoReCa network. Partnerships will be established with health and nutrition influencers to increase brand awareness.

Promotion will include social media campaigns, in-store tastings, participation in food fairs, and the creation of a dedicated website. Emphasis will be placed on storytelling: the origin of ingredients, fermentation benefits, and the product's health impact will be communicated through visual content and testimonials.

VII. Financial Analysis: (300 words)

For the development of the "Fermented Meat Products from Chicken with Pea Protein and Quinoa," a detailed cost analysis was conducted, estimating expenses related to raw materials, processing, packaging, promotion, and distribution. The estimated production cost per unit (150g) is approximately €1.80. The main ingredients – chicken meat, pea protein, quinoa, and fermentation cultures – represent around 60% of the total cost. Processing and (eco-friendly) packaging add an additional €0.60 per unit.

The pricing strategy aims for a retail price of approximately €3.90/unit, generating a gross profit of around €2.10. It is estimated that in the first year, about 50,000 units will be sold, resulting in total revenue of €195,000.

The initial investment required for product development can be estimated as follows: approximately €20,000 for research activities, €10,000 for recipe formulation and optimization, €20,000 for market testing, €20,000 for branding efforts, and an additional €20,000 allocated for the product launch. Recurring annual operational costs (including raw materials, production, and logistics) are projected to be approximately €90,000.

Based on these figures, the project is financially viable, with an estimated return on investment (ROI) of approximately 60% in the first year. An annual sales growth of 20% is projected due to growing consumer interest in healthy and innovative products

VIII. Challenges and Risks: (200 words)

One of the main risks is market acceptance, since the product combines new ingredients (pea protein, quinoa) with a traditional fermented product. There is a possibility of reluctance from consumers accustomed to classic tastes.

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Supply chain risks, such as price fluctuations of raw materials or availability of organic ingredients, can affect costs and production. Also, the fermentation process must be carefully monitored to ensure food safety and quality consistency.

To mitigate these risks, educational campaigns and tastings will be conducted to familiarize consumers with the product. Long-term contracts with suppliers will secure supply stability, and quality control systems will be rigorous and continuous.

IX. Conclusion: (150 words)

The formulation of fermented chicken salami enriched with pea protein and quinoa will yield a nutritionally improved product with enhanced functional properties. The addition of pea protein notably increases the total protein content without compromising textural integrity or sensory acceptability. Quinoa served as a source of bioactive compounds, including polyphenols and dietary fiber, thereby enhancing the antioxidant capacity of the final product. This hybrid formulation is believed to demonstrate improved water-holding capacity and overall product stability, with no detrimental impact on fermentation dynamics or microbiological safety. Furthermore, the integration of plant-based ingredients contributes to more sustainable meat processing by partially replacing animal-derived protein, aligning with contemporary dietary preferences such as flexitarianism. Future research should focus on the incorporation of natural antioxidants and assessment of long-term storage stability. Overall, this novel product offers a nutritionally superior, functionally enhanced, and economically feasible alternative to conventional fermented meat products, catering to evolving consumer demands.

X. References and Appendices (up to 20 references)

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