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Development Characterization And Optimization Of A Plant Based Mock Egg Using Quinoa Milk And Cassava Flour: A Novel Approach To Vegan Food Technology

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Abstract: The development and optimization of plant-based alternatives to animal products are gaining importance in response to sustainability and health-conscious dietary trends. This study investigates the creation of a novel plant-based mock egg using quinoa milk and cassava flour as primary raw materials. Quinoa milk, a nutrient-dense plant beverage rich in proteins, essential amino acids, and micronutrients such as iron and magnesium, was combined with cassava flour, a gluten-free starch with excellent binding and textural properties, to create a mock egg that mimics the texture, flavor, and nutritional profile of a traditional egg. The formulation was optimized for sensory characteristics, nutritional content, and technological properties. Nutrient analysis showed that the mock egg was rich in plant-based protein and key micronutrients, aligning with the nutritional benefits of traditional eggs. The shelf-life stability of the mock egg was assessed over 5 days under refrigeration (4°C), with samples evaluated for texture, color, and sensory attributes, and microbial growth was monitored. Results indicated that the mock egg maintained stability in both texture and nutrition up to day 3, with minimal microbial growth. However, a decline in sensory acceptability was observed on day 5, suggesting further optimization of preservatives and storage conditions. This study contributes to the field of vegan food technology, offering a sustainable and nutritious alternative to eggs while utilizing quinoa milk and cassava flour as eco-friendly raw materials.

Index Terms- Plant-based mock egg, quinoa milk, cassava flour, vegan, nutrient analysis, shelf-life, microbial growth, sustainable ingredients.

I. INTRODUCTION

The search for plant-based egg alternatives is growing quickly due to the demand for healthy, allergy-free, and environmentally friendly foods. Recent studies have shown that quinoa milk, which is rich in proteins and essential amino acids, works well as an egg substitute—especially when combined with cassava flour, which is high in starch and has strong binding properties. Together, these ingredients can copy the key functions of real eggs, such as emulsifying, gelling, and holding moisture, which are important in cooking and baking.Research has also shown that the way plant proteins and starches interact can improve the texture and taste of vegan egg alternatives. Other studies (Zhao et al., 2024) found that by adjusting oil droplet size and protein content, the elastic and thickening properties of real eggs can also be mimicked. Quinoa and cassava have also been used in gluten-free baking, adding nutritional value and improving consumer acceptance (Patel et al., 2024). Overall, making a mock egg using quinoa milk and cassava flour shows promise in creating plant-based foods that are both nutritious and functionally effective.

The food industry is also responding to rising consumer demand for safe, natural, and healthy foods. This includes foods that are plant-based, dairy-free, gluten-free, and those with added health benefits. Since 2013, when the United Nations declared the International Year of Quinoa, its global use and production have increased greatly (Wang, Wang, et al., 2020). Quinoa is now seen as a valuable ingredient because of its high protein, fiber, and mineral content. In Colombia, quinoa research has become important, focusing on areas such as postharvest handling, plant breeding, and soil management.Cassava flour is also becoming more popular as a gluten-free flour alternative. It is rich in fiber, minerals, and carbohydrates, and its neutral taste makes it easy to use in baked goods and pasta (Arias et al., 2022). Its use is expected to grow by 4.5% per year between 2020 and 2025 (Grand View Research, 2020). Cassava also has possible health benefits, such as anti-inflammatory properties, antioxidants, and a lower glycemic index than wheat flour (Oliveira et al., 2020).With more people choosing vegetarian, vegan, or flexitarian diets, the need for plant-based egg substitutes is growing. Mock eggs can be made from many ingredients, including tofu, temper, aquafaba, and algal protein (Lam et al., 2020). According to research (Chen et al., 2020), the functional properties of these egg alternatives—such as foaming, emulsifying, and thickening—can be similar to real eggs. In this study, we explore the use of quinoa milk and cassava flour to create a plant-based mock egg that meets the same functional needs as real eggs while also being healthier and more sustainable. The research focuses on understanding how these two ingredients work together, how they behave when heated, and whether they can match the taste, texture, and nutrition of real eggs.

II.MATERIALS AND METHODS

Selection of Topic

This study aims to develop a nutritious mock egg using quinoa milk and cassava flour to meet growing consumer demand for healthy, sustainable, and plant-based foods. Quinoa is a protein-rich, gluten-free seed containing all essential amino acids, fiber, and antioxidants, while cassava is a starchy root high in energy, vitamin C, and resistant starch that aids digestion. Both are suitable for gluten-free and special diets. Their plant-based milks are lactose-free, often fortified, and widely used in cooking and baking. This research explores the nutritional benefits, functionality, and potential of combining these ingredients to create a shelf-stable, vegan-friendly egg alternative.

Selection of Ingredients

Quinoa milk is a nutritious plant-based drink rich in protein, fiber, vitamins, and minerals, making it a healthy alternative to dairy milk. Proper processing techniques help reduce bitterness and improve its taste and stability. Cassava flour, made from the cassava root, is a gluten-free ingredient high in carbohydrates, fiber, and essential minerals.Cassava flour supports digestive health, helps control blood sugar levels, and provides lasting energy, though it should be consumed in moderation due to its high calorie content. Together, quinoa milk and cassava flour offer valuable options for creating nutritious and functional plant-based foods.

Preparation of Quinoa Milk

To prepare quinoa milk, quinoa seeds are first rinsed well under running water to remove bitter-tasting saponins, then soaked for 2 to 7 hours to soften them. After soaking, the quinoa is cooked in fresh water until soft and creamy. The cooked quinoa is blended with water in a 1:3 ratio until smooth, then strained using a fine mesh, cheesecloth, or nut milk bag to separate the milk from the pulp. Optional ingredients like natural sweeteners, vanilla, or cinnamon can be added for flavor, and nutrients like calcium or vitamin D may be added for fortification. The milk should be stored in a sealed container in the fridge and used within 3 to 5 days, shaking well before each use.

Standardization of quinoa milk and cassava flour plant based mock egg

Ingredients	Formulation				
	Standard	Variation1	Variation2	Variation3	Variation4
Quinoa milk	25ml	50ml	75ml	50 ml	100ml
Cassava flour	25g	50g	75g	50	100g
Agar agar	2 g	4 g	6g	8g	10 g
Corn starch	2g	5g	10g	12g	15g

Preparation of Quinoa Milk-Based Egg White Substitute

To make a quinoa milk-based egg white substitute, heat a measured amount of quinoa milk (25–100 ml) and mix in agar-agar flakes (2–8 g, based on the milk quantity) while stirring until fully dissolved. Bring the mixture to a gentle boil and simmer for 1–2 minutes. Add a pinch of salt, stir well, then let it cool to room temperature without letting it set. Once cooled, whisk or blend the mixture until it becomes foamy and light, like egg whites. For a firmer texture, refrigerate for 10–15 minutes and whisk again if needed. This substitute can be used in recipes like meringues or mousses and should be stored in the fridge for up to 24 hours, rewhisking before use.

Preparation of Cassava Flour-Based Egg Yolk Substitute

To prepare a cassava flour-based egg yolk substitute, combine cassava flour (25–100g), corn starch (1 tsp per 25g of cassava flour), and turmeric powder in a bowl. Gradually add hot water, stirring to form a smooth paste. Cook the mixture over low to medium heat, stirring constantly, until it thickens into a semi-solid consistency. Remove from heat, then add butter (1 tsp per 25g of cassava flour) to create a glossy texture. While still warm, shape the mixture into small round portions to mimic egg yolks. Let them cool completely before using in recipes like custards or sauces. Store in an airtight container in the fridge for up to 24 hours, reheating and reshaping as needed.

IV.RESULT AND DISSCUSSION

Sensory analysis of plant based mock egg

S. no	Criteria	Standard	Selected product (sample d)
1	Appearance	4.8±0.46	4.8±0.55
2	Colour	4.9 ±0.18	4.9±0.25
3	Flavour	4.9±0.18	4.8±0.48
4	Texture	4.8±0.48	4.8±0.46
5	Taste	4.9±0.40	4.8±0.50

Give the mean sensory scores for the overall acceptability obtained by the sensory evaluation of standard mock egg and varying proportions of Quinoa milk and cassava flour incorporated mock egg with the help of score card. So from the result, we can conclude that sample D was highly accepted by the semi-trained panel members when compared to other samples like sample A, B, and C. So that we can conclude that Sample D was selected as the best product.

Nutrient Analysis

S. No	Nutrients	Products	
		Standard Mock egg	**Quinoa milk and cassava flour incorporated mock egg**
1	Energy (kcal)	340	358
2	Carbohydrate (g)	70.0	65.2
3	Protein (g)	10.2	13.8
4	Fat (g)	2.1	4.8
5	Ash (g)	1.4	2.2
6	Moisture (g)	12.3	13.0

The nutrient value of energy, protein, carbohydrate, fat, ash, and moisture was higher in the quinoa milk and cassava flour-based mock egg compared to the standard mock egg. The incorporated ingredients provided a higher amount of nutritive value compared to the standard. The protein content in the quinoa milk incorporated cassava flour mock egg (Sample D) was found to be 13.8g, carbohydrate content 65.2g, fat 4.8g, ash 2.2g, and moisture 13%, which were all found to be higher than the standard mock egg values.

Shelf life

S. No	Days	Standard	Best Product	Best Product	Standard
		Zip Lock Cover	**Air Tight cover**	**Air Tight cover**	**Zip Cover**
1	1st day	5.0 ± 0.00	5.0 ± 0.00	5.0 ± 0.00	5.0 ± 0.00
2	3rd day	4.8±0.20	4.9 ± 0.10	5.0 ± 0.00	4.9 ± 0.10
3	5th day	4.5±0.40	4.7 ± 0.20	4.9 ± 0.10	4.7 ± 0.20

The sensory scores of quinoa milk and cassava flour incorporated mock egg showed a slight decline over 5 days. Both standard and best products maintained higher stability when packed in airtight containers compared to zip lock covers. The best product in airtight packaging consistently retained the highest acceptability throughout storage.

Microbial Analysis

Name of the Product	Storage Day	Total Plate Count (CFU/g)	Interpretation	pH
Plant-Based Mock Egg	Day 1	≤102	Good	6.2
	Day 3	≤102	Good	6.0
	Day 5	$\leq 10^4$	Satisfactory	5.8

- **Day 1 (Plate A)**: No bacterial colonies observed on Nutrient Agar.
- **Day 3 (Plate B)**: Plates remained sterile, confirming microbial stability.
- **Day 5 (Plate C)**: Sparse colonies observed on Nutrient Agar indicating a mild increase in aerobic microbes (≤10 CFU/g)

Cost Calculation

	STANDARD		FINAL PRODUCT	
Ingredients	Quantity (gm)	Price (rs)	Quantity (gm)_	Price (rs)
Potato	20	4	_	_
Quinoa	_	_	20	15
Agar agar	5	3	5	3
Soya milk	20	10		
Corn starch	5	1	5	1
Cassava flour	10	2	10	2
Turmeric powder	5	2	5	2
Packaging	1 unit	3	1 unit	3
Total cost		25		30

Packaging and labeling

- The packaging of Plant based Mock Egg plays a crucial role in protecting the product, maintaining freshness, extending shelf life, and enhancing consumer appeal.
- In the future, the packaging of quinoa and cassava flour plant based mock egg will be designed to ensure freshness, sustainability, and consumer convenience.
- It involves selecting suitable materials, design, and labeling that align with food safety standards and market expectations.

V.CONCLUSION

The findings suggest that the mock egg made from quinoa milk and cassava flour holds strong market potential, especially in the context of the growing demand for plant-based alternatives. Consumers are becoming increasingly aware of the benefits associated with plant-based diets, and there is a rising openness to trying nutritious egg substitutes, provided they deliver desirable qualities such as proper texture, appealing taste, and cost-effectiveness. The quinoa milk and cassava flour mock egg, with its high nutritional value and favorable sensory properties, fits well into this emerging trend. This innovative product could be successfully introduced through multiple channels, including supermarkets, health food stores, online platforms, and restaurants, specifically targeting health-conscious individuals, vegans, vegetarians, and environmentally aware consumers. Moreover, its formulation without animal-derived ingredients makes it highly suitable for individuals with dietary restrictions such as lactose intolerance, egg allergies, or specific ethical concerns regarding animal welfare and sustainability. The development of this mock egg not only provides a nutritious

and functional alternative but also supports broader public health goals and environmental initiatives, making it a promising and socially responsible food innovation.

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