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Summary of the seed money project

Wheat, one of the oldest cultivated cereal crops, has served as a fundamental source of energy and nutrition across civilizations for millennia. Among its most culturally significant products is *chapatti*—a traditional, unleavened Indian flatbread made from whole wheat flour. Chapatti is eaten every day by millions of people in the Indian subcontinent and around the world. It not only provides energy but also gives important nutrients like fiber and protein. As a staple food, it plays a central role in Indian diets, akin to the role of bread in the Western world.

This project explores the standardization, development, and value addition of various Indian flatbreads—especially chapatti—by evaluating their **physico-chemical, nutritional, and sensory properties**, along with **shelf life extension** through ingredient modifications and packaging innovations. The increasing demand for ready-to-eat traditional foods, driven by urbanization, time constraints, and evolving lifestyles, has made the development of shelf-stable and nutritionally enhanced chapatti variants a timely innovation.

Historical and archaeological records show that wheat and flatbread consumption dates back to the Neolithic era, with chapatti-like products appearing in ancient civilizations such as the Indus Valley and Egypt. Over time, chapatti has remained integral to Indian food culture and has now become a focus of technological and nutritional enhancement in modern food science.

This report also investigates the incorporation of functional ingredients—such as spinach, yeast, wheat bran (chokar), and arabinoxylans—to improve both the **quality and shelf life** of chapattis. Arabinoxylan enrichment, in particular, has shown significant improvements in dough rheology, softness, and sensory appeal. Further, microbial and sensory studies are employed to monitor product stability over time.

The study evaluates several product types aimed at meeting diverse market demands, including:

- Fresh chapattis (1–2 days shelf life),
- Medium shelf-life chapattis (3–5 days with mild preservatives),

- Long shelf-life chapattis (up to 4–5 months via packaging and sterilization),
- Frozen chapattis (half-baked or fully baked).

Market analysis reveals significant potential for growth in the ready-to-eat chapatti segment, targeting working households, students, elderly individuals, disaster relief efforts, and institutional kitchens such as hospitals, hostels, and the armed forces. The adoption of chapatti-making machines and packaging innovations supports scalability and commercialization.

The key objectives of the study are:

- To standardize and develop diverse Indian flatbread varieties,
- To evaluate their physico-chemical, nutritional, and sensory characteristics,
- To analyze the shelf life of the developed products,
- To assess the techno-economic feasibility of Indian flatbread production and commercialization.

This report positions chapatti not only as a cultural staple but also as a promising focus for innovation in the processed food industry. The findings are expected to contribute to nutritional improvement, convenience, and industrial scalability of Indian flatbread products in both domestic and international markets.

The review chapter provides a concise overview of research on Indian flatbreads, particularly focusing on their technology, production, and shelf-life evaluation. It highlights the scientific work related to wheat, the primary ingredient for Indian flatbreads like chapati, and its processing. Wheat is an essential global crop, especially in India, where it's the second-largest producer, with chapati being a predominant wheat-based product. The chapter also discusses the three main wheat species—Triticum aestivum, Triticum durum, and Triticum dicoccum—focusing on their suitability for chapati making. Wheat varieties with specific characteristics, such as protein content, water absorption, and diastatic activity, are crucial for producing soft, pliable chapatis.

Further, various studies have evaluated the physico-chemical and sensory characteristics of wheat for chapati quality. The review presents historical and modern research, including the development of wheat cultivars in India aimed at improving chapati quality. Notable findings include the correlation between wheat's chemical properties (e.g., protein content, sugar levels) and the texture, taste, and storage quality of chapatis. The review emphasizes the need for wheat varieties with high water absorption, good puffing ability, and excellent sensory attributes, which are essential for producing high-quality chapatis.

Research from different institutes and agricultural trials over the years has contributed to the ongoing development of better wheat varieties suited for chapati production. These studies also suggest that wheat varieties should have specific qualities, such as high protein content (10-13%), good water absorption, and certain diastatic activities to ensure the production of superior chapatis.

Composite Flours for Chapatti

Cereals are a staple food in Asia, particularly in the Indian subcontinent. However, cereals are often deficient in essential amino acids and micronutrients, which has led to the widespread issue of protein-calorie malnutrition, especially among populations with poor bioavailability of these nutrients due to the presence of antinutritional factors like phytates and condensed tannins. To address this issue, efforts have been made to fortify cereals with other nutrient-rich food materials, resulting in the development of composite flours. Composite flours are mixtures of various flours from cereals and other food materials, such as tubers, legumes, oilseeds, and vegetables, designed to partially or entirely replace wheat flour in baked and pasta products.

The term "composite flour" has been defined in various ways:

1. A mixture of flours, starches, and other ingredients intended to replace wheat flour in baked goods (De Reuter, 1978).
2. A combination of wheat and non-wheat flours used for producing leavened and non-leavened baked goods (Dandy, 1992).
3. A blend of flours from tubers, legumes, cereals, and sometimes wheat flour (Seibel, 2011).

Historically, wheat and non-wheat flours have been used in times of wheat scarcity, either due to climatic or economic factors, with a focus on improving nutritional quality and encouraging the use of local raw materials. In the 1960s and 1970s, composite flours became a key focus of cereal research, particularly in developing countries, under the support of organizations like the FAO and the International Association for Cereal Science and Technology (Chatelanat, 1973).

Cereal proteins are generally incomplete, particularly lacking essential amino acids like lysine. This reliance on cereals as a protein source has contributed to malnutrition, especially among the poor. Supplementing cereal-based flours with other protein-rich materials, particularly legumes, offers a promising solution to this problem. Food materials rich in essential amino acids can be used to supplement wheat or other cereal flours, improving their amino acid profile and making them suitable for products like chapattis, which are a staple in many diets.

The acceptability of these composite flours for chapattis is critical, as even the most nutritious food is ineffective if it is not well-received by consumers. Various non-wheat ingredients, including tubers, legumes, pulses, oilseeds, cereals, fruits, and vegetables, have been used to prepare composite flours for chapattis. The following sections explore the different types of composite flours and their nutritional benefits:

1. Tuber-Based Composite Flours

Potatoes are a nutritious tuber with high levels of antioxidants, including vitamin C, carotenoids, and anthocyanins. Potato protein is particularly rich in lysine, making it a valuable

supplement for cereal-based products. The inclusion of potato flour in chapattis has been found to improve water retention and softness (Singh et al., 2005).

2. Cereal-Based Composite Flours

Cereals provide a significant portion of the diet in the Indian subcontinent but are deficient in essential amino acids. Blending different cereals may improve the acceptability and nutritional value of chapattis. For instance, blending durum wheat with aestivum wheat yields acceptable chapattis, and adding barley flour to wheat flour improves protein content and water absorption (Sood et al., 1992). Other grains like millet and sorghum have also been successfully blended with wheat to enhance nutritional value and improve chapatti quality.

3. Legume/Pulses-Based Composite Flours

Pulses, such as chickpeas, cowpeas, and soybeans, are rich in plant proteins and essential amino acids, particularly lysine. Blending legume flours with wheat improves the protein content and overall nutritional value of chapattis. For example, chickpea flour enhances dough stability and protein efficiency, while soy flour can be added up to 10% in chapattis without affecting acceptability (Bajwa, 1997).

4. Oilseed-Based Composite Flours

Oilseeds like peanut and flaxseed are rich in protein and essential fatty acids. Adding defatted peanut flour to wheat flour improves the nutritional quality of chapattis, increasing protein and lysine content (Bhat and Vivian, 1980). Similarly, flaxseed, with its high levels of omega-3 fatty acids, has shown promise in improving the quality of chapattis when blended with wheat flour (Manjula Sasikumar, 2015).

5. Fruits and Their Products-Based Composite Flours

Fruits like Jamun (Indian blackberry) are rich in vitamins, minerals, and bioactive compounds, making them a valuable addition to composite flours. Jamun has antioxidant, anti-diabetic, and anti-cancer properties (Choudhary and Mukhopadhyay, 2012).

The use of composite flours for chapattis offers a promising way to enhance the nutritional value of a staple food while maintaining its cultural and culinary significance. The incorporation of diverse food materials, including tubers, cereals, legumes, oilseeds, and fruits, can address nutrient deficiencies in the diet and improve the overall health of populations relying on cereal-based foods.

This research was conducted at the Food Technology and Research Department, TC College, Baramati, Maharashtra, during 2023-24, focusing on the development, evaluation, and shelf-life study of Indian flatbreads (chapatis). The raw materials used, such as wheat (Lokwan and Sharbati varieties), sorghum, millets, ragi, and other ingredients like spices, salt, and oils, were sourced from the local market in Baramati, Pune. The study also utilized various chemicals and packaging materials, including food-grade chemicals for processing and HDPE/LDPE pouches for packaging.

Preparation Process

The wheat was cleaned, sieved, and milled in stages to produce whole wheat flour. The flour was then blended with ingredients like salt, oil, and food additives (e.g., CMC, gluten, preservatives) to prepare dough. The dough was manually rolled into portions and baked on a hot plate. The final product was vacuum-sealed in polypropylene bags and stored at room temperature, in refrigerators, and freezers.

Standardization and Evaluation

Five different formulations of flatbreads were tested, incorporating varying amounts of additives like CMC, vital gluten, potassium sorbate, and ascorbic acid. Key physical parameters like weight, diameter, and thickness were measured. Proximate analysis was performed to assess moisture, fat, protein, fiber, ash, and carbohydrate content. The study also evaluated sensory qualities such as appearance, texture, and flavor using a 9-point hedonic scale.

Functional Properties

The water and oil absorption capacities of the flatbreads were evaluated to assess their functional properties.

Storage Study and Microbial Analysis

The shelf-life of the most acceptable flatbread sample was studied for three months. Microbial analyses, including Total Plate Count (TPC) and yeast and mold count, were conducted every 15 days to monitor the stability of the product under different storage conditions.

Techno-economic Feasibility

The cost of producing the Indian flatbread was assessed by calculating the raw material cost, processing cost (20% of the raw material cost), and the final cost per kilogram of the product. This study helps in understanding the feasibility of scaling up production while ensuring product quality and safety.

This comprehensive study contributes to improving the shelf-life, nutritional quality, and consumer acceptance of Indian flatbreads, with potential for commercialization.

The investigation titled “Development, Quality Evaluation, and Shelf-Life Studies of Different Types of Indian Bread” aimed to create a shelf-stable Indian flatbread (IFB) by fortifying it with various ingredients to improve its shelf life. The study focused on assessing the physico-chemical, nutritional characteristics, and shelf life of the developed breads. It also explored the techno-economic feasibility of the product.

The research involved formulating IFB with different ingredients such as CMC, vital gluten, potassium sorbate, and calcium propionate. Various wheat varieties, including Khapli, Sharbati, and Lokwan, were tested for their suitability in chapatti making, with Sharbati being chosen for the study due to its market availability and cost-effectiveness.

Proximate analysis of the chapattis revealed that moisture, protein, fat, fiber, and ash content varied among samples, with a noticeable increase in protein, fiber, and ash content in the

fortified samples. Sensory evaluations showed that sample-3, made with a specific combination of ingredients, received the highest ratings for color, flavor, texture, taste, and overall acceptability.

Shelf-life studies on sample-3 showed that microbial growth (Total Plate Count and Yeast & Mould count) remained within acceptable limits up to 12 days at room temperature.

In conclusion, the study demonstrated the feasibility of developing a shelf-stable Indian flatbread using innovative formulations, enhancing its nutritional profile and extending its shelf life, while maintaining good sensory characteristics.

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