International Journal of Agriculture and Environmental Research

ISSN: 2455-6939

Volume: 11, Issue: 04 "July-August 2025"

EVALUATION OF SENSORY ATTRIBUTES AND QUALITY ANALYSIS OF JACK SEED FLOUR BASED COOKIES

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DOI: https://doi.org/10.51193/IJAER.2025.11418

Received: 15 Jul. 2025 / Accepted: 28 Jul. 2025 / Published: 12 Aug. 2025

ABSTRACT

The world-wide desire for sustainable as well as functional foods alternatives has led to an explosive cottage industry in terms of interest in exploiting the under-explored farm produce i.e., under-utilized resources, such as jackfruit seeds, merely due to their low keeping quality and shelf life despite of their richness in nutrition values, which are thrown to trash. The study discusses the feasibility of using Jack seed flour (JSF) as a partial replacement for wheat flour in cookie baking with emphasis on the sensory properties. Five different trials in cookie with different formulations were conducted just by varying the proportions of JSF, wheat flour, and rice flour and other ingredients. Sensory evaluation of the products was scored on 5-point Hedonic scales and 6 parameters such as taste, flavor, color, smell, sweetness, and texture. A group of untrained panellists selected randomly were asked to evaluate the sensory attributes of each trial. Statistical analysis such as one-way ANOVA was used to evaluate the significant differences between the trials with the sensory data. The results revealed that Trial 5 using JSF along with wheat and rice flour, Jaggery, and Cashew nuts was scored the highest amongst all the sensory attributes namely taste (4.7), texture (4.7), and flavour (4.65), with the least difference between individuals. There was a difference in key sensory attributes (taste and sweetness), which reveals the significance of formulating ingredients. These results justify loading with up to 60% of JSF as a versatile replacement of wheat flour in confections, providing an effective way to increase nutritional value and reduce food waste. In the present investigation composite Jackfruit seed flour (JSF) was prepared and used to develop Jackfruit seed cookies and analysed for nutritional composition. The results revealed that JSC had titratable acidity (1.44%), ash (3.12%), protein (5.40%), crude fat (6.50%), crude fibre (11.30%) and significantly extra high in protein, fat and ash content compared

ISSN: 2455-6939

Volume: 11, Issue: 04 "July-August 2025"

to the standard wheat cookies. The findings highlight the potential of JSC as a nutrient-rich snack (functional food) for a balanced diet.

Keywords: Jackfruit seed, functional cookies, sensory evaluation, by-product utilization, food innovation

1. INTRODUCTION

The growing interest in functional foods has encouraged researchers to explore underutilized agricultural by-products for health benefits and sustainability. Jackfruit (*Artocarpus heterophyllus*) primarily consumed for its fruit pulp, produces seeds rich in starch, protein, and micronutrients. Native to the Western Ghats of India and Malaysia, jackfruit is also found in the Caribbean, Florida, Brazil, Australia, Puerto Rico, and many Pacific Islands, as well as central and eastern Africa and Southeast Asia (Prakash *et al*., 2009). Jackfruit seed has a high nutritional value since it includes prebiotic chemicals, polyphenols, fibre (3.19%), and starch (22%) (Rodríguez *et al*., 2021). According to studies, jackfruit seeds can control blood sugar levels and suppress hunger, which can help people lose weight. Furthermore, jackfruit seed has been identified for its ability to reduce inflammation, mitigate oxidative stress, aid in digestion, and improve cognitive function. Jackfruit is extensively cultivated and processed in these places, but setbacks like short shelf life and insufficient processing facilities indicate that its full commercial potential is still mostly unexplored. About 10–15% of the total weight of jackfruit is composed of up of seeds. It's also crucial to note that Maskey *et al*. (2020) revealed that an astounding 2.96 million metric tons of jackfruit seeds are wasted annually worldwide (Nsubuga *et al*., 2021). Despite the high nutritional value of these seeds, lack of utilization and low popularity are the main causes of such waste (Maskey *et al*., 2020). These seeds are often discarded, leading to waste despite their nutritional potential (Swami *et al.,* 2012). Recent studies have explored jackfruit seed flour as an ingredient in baked goods due to its high dietary fibre and antioxidant properties (Ocloo *et al*., 2010). However, when roasted, jackfruit seeds can be transformed into versatile flour that, when combined with other flours like wheat enhances the durability and enriches the nutritional aspects of a wide range of products. This jackfruit seed powder serves as alternative flour, particularly in baking and confectionery, when blended with wheat flour. Incorporating jack seed flour into cookies offers a strategy to reduce waste and enhance nutritional value (Nordin *et al*., 2024). Any effective business system must include quality management and new product development as strategically significant operations and components (Grujić *et al.*, 2011; Hansen and Hamilton, 2011). A new product must be developed in line with the demands of the target market and end-user in order to find a place and stay on the market (Recurreccion, 1998; Sijtsema *et al*., 2004; Gielens and Steenkamp, 2007; Grunert *et al*., 2008). The product's sensory attributes are crucial quality factors that affect the final product's reputation on the market and the extent to which its target market will find it appealing and purchase it. According to the latest research findings, the

ISSN: 2455-6939

Volume: 11, Issue: 04 "July-August 2025"

product's quality and critical sensory attributes can be assessed and managed through descriptive analysis or consumer evaluation to determine whether improvements were made to the product's overall quality or a specific property (Bahamonde *et al.*, 2007; Grunert *et al*., 2008; Grujić and Spaho, 2010; Grujić and Grujić, 2011). In order to ascertain the ideal ratio for utilizing jackfruit seed flour in cookie production, the main goal of the study is to examine the degree of customer acceptance of jackfruit seed cookies. The results of this study can identify a viable and affordable substitute for the baking and confectionery industries by investigating the reception and feasibility of using jackfruit seed flour in cookie making. However, consumer acceptance depends largely on sensory attributes. This study evaluates the impact of jack seed flour on the sensory characteristics of cookies.

1.1 Health benefits of Jack seed:

These seeds are recognized for their positive impact on digestion, anti-carcinogenic properties, and potential to reduce skin wrinkles (Chhotaray and Priyadarshini, 2022). In addition, they are good source of essential minerals like calcium, magnesium, phosphorus, sodium, iron, copper, zinc, potassium, and manganese. These minerals play crucial roles, ranging from supporting bone health to influencing muscle and nerve function and regulating the body's hydration levels (Hajj *et al*., 2022). Jack seeds have two lectins i.e., artocarpin and lectin, which bestows immunological properties. Additionally, they serve as a substantial source of dietary fibre (Astuti *et al*., 2022). An increased intake of dietary fibre has been associated with various health benefits, including lowered blood pressure, reduced cardiometabolic risk factors, and a decreased risk of developing cardiovascular disease (Biswas *et al*., 2022). An increased intake of dietary fibre has been associated with various health benefits, including lowered blood pressure, reduced cardiometabolic risk factors, and a decreased risk of developing cardiovascular diseases (Biswas *et al*., 2022). Boiling, roasting and fermentation can help to reduce the anti-nutritional factors of the jackfruit seeds (Abiola *et al*., 2018).

1.2 Antinutritional properties of Jack seed:

Antinutritional compounds such as trypsin inhibitor present in jackfruit seed was (1.14 to 1.41), and tannin (0.01 - 0.04%) and phytate (0.05 - 0.30 g) present in very small amounts (Lasekan et al., 2015). These compounds can strongly chelate with cations including calcium, magnesium, zinc, and iron to produce insoluble salts (Mohd Bakri et al, 2021). These antinutrients can be deactivated by heat, so cooking jackfruit seeds through methods like roasting or boiling can significantly reduce their negative impact (Neelanjana et al., 2023).

1.3 Shelf life of cookies:

ISSN: 2455-6939

Volume: 11, Issue: 04 "July-August 2025"

A food shelf life is defined as the time duration the product, stored under certain temperature conditions, changes a certain extent, and is still considered acceptable by manufacturer, consumer, and current food law (Breda, et al., 2012). Shelf life is a very important indicator to specify quality of a food product in a specific time (Kurniadi et al., 2019). Shelf life depends on extrinsic factors such as packing properties, ambient temperature and relative humidity, oxygen and light concentration, transport and handling, as well as intrinsic food factors such as water activity, acidity, pH, and composition (Mastrandrea, et al., 2017). A gradual decline was observed in sensory parameters (i.e., texture, taste, colour, aroma and overall acceptability) with increase in storage time (Asadi et al.2022). Normally addition of preservatives and freezing enhances shelf life.

2. MATERIALS AND METHODS

2.1 Preparation of Jack seed cookies

After physically removing the seeds' mucilage peel, any remaining dust and debris were cleaned off with tap water. Water was added to the seeds and boiled for half an hour. The water was drained and the cooked seeds were rinsed thoroughly. After being washed, the jackfruit seeds were then chopped into tiny bits and sun dried for 16 hours. After drying, the seeds were ground and made into flour. Jaggery and oil were mixed till smooth paste was obtained. The sieved wheat flour, rice flour and jackfruit seed flour were added to the jaggery and oil mixture to make soft dough. Jackfruit essence and cardamom powder were added to the dough. Then the dough was sheeted to thickness of about 3-4 mm and cut to form cookies of 5cm diameter which was baked in an oven for 20 min at 165^{o}C. After baking, the cookies were cooled to room temperature (21°C) and packed. About five trials were conducted to optimize the various attributes of the jack seed cookies. The ingredients for each trial were added as shown in the Table.1.

ISSN: 2455-6939

Volume: 11, Issue: 04 "July-August 2025"

Table 1: List of Ingredients used in each Trial

Ingredients	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
Jack seed flour(g)	60	60	80	60	60
Wheat flour(g)	40	20	20	40	20
Rice flour (g)	-	20	-	-	20
Powdered sugar (g)	50	50	-	-	-
Jaggery (g)	-	-	60	70	70
Fat (g)	60	60	60	-	60
Cardamom powder (g)	2	2	2	2	2
Ghee (g)	-	-	-	-	-
Butter (g)	-	-	-	60	-
Cashew (g)	-	10	10	10	10
Jack fruit essence (ml)	-	0.5	0.5	0.5	0.5

2.2 Sensory Evaluation

A group of untrained panellists from the Gandhigram Rural Institute, Dindigul rated each trial on a 5-point Hedonic scale for taste, flavour, appearance, odour, sweetness and texture. The evaluation was conducted in a well-lit location using coded samples and water rinses between tastings.

2.3 Hedonic Sensory Analysis

The methodology for this analysis was adapted from Caliskan *et al*. (2020). The sensory evaluation was held involving a group of untrained panellists chosen at random and aged between 18 and 21 years from the University community. In this sensory test, five samples were presented for evaluation. These samples were given to the participants for testing. Each respondent documented their impressions of the product, utilizing a 5-point hedonic scale ranging from 1, representing 'dislike extremely,' to 5, representing 'like extremely.' This assessment covered six criteria, including taste, flavour, appearance, odour, sweetness and texture. To facilitate the testing process, each sample was clearly labelled to enable easy differentiation by the participants.

2.4 Statistical Analysis

Data were subjected to one-way ANOVA, and means were compared using Tukey's HSD test ($p < 0.05$).

ISSN: 2455-6939

Volume: 11, Issue: 04 "July-August 2025"

2.5 Quality Analysis of JSC

Various parameters namely titratable acidity, ash, protein, crude fat and crude fat were analysed using standard procedures (FSSAI, 2016).

3. RESULTS AND DISCUSSION

The study demonstrates that it is possible to apply 60% of the wheat flour for JSF replacing in cookies with good sensory quality. This is advantageous when considered from a sustainability standpoint and constitutes a healthy alternative in bakery. Further research could investigate shelf-life stability, consumer market testing and nutritional profiling.

The sensory attributes of JSC were tested over five different formulation trials using a panel of respondents as shown in fig.1. Each trial was assessed for six sensory parameters: taste, flavour, appearance, odour, sweetness, and texture, and scores were assigned on a 5-point hedonic scale. The aim was to identify the most acceptable formulation based on panellist preferences and consistency of sensory attributes.

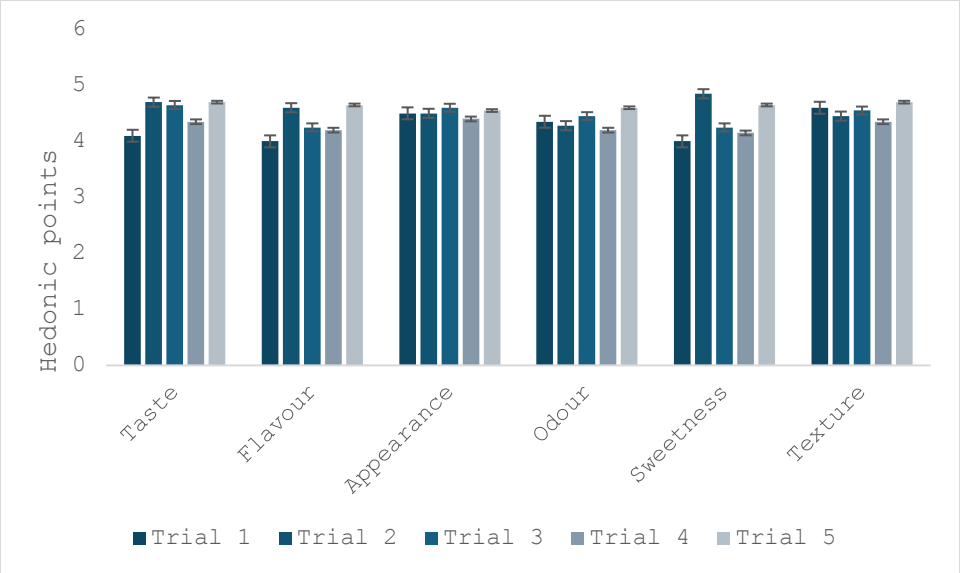

Fig. 1: Sensory evaluation of JSC

Trial 5 had the highest mean scores for most attributes (texture: 4·70; taste: 4·70; and flavour: 4·65). In addition to, within Trial 5, the standard deviations were still low, showing a strong consistency between participants. In contrast, Trial 2 had the highest mean sweetness score (4.85), but the smallest standard deviation (0.24), indicating high and unchanging panel preference for that level of sweetness in the final product.

ISSN: 2455-6939

Volume: 11, Issue: 04 "July-August 2025"

The sensory evaluation reveals statistically and practically significant differences across trials, particularly in taste, and sweetness (fig.1.). Trial 5 emerged as the most preferred formulation, combining high sensory appeal with consistency across respondents. Trial 2 was notable for its sweetness but showed higher variability in flavour scores. Therefore, Trial 5 was recommended for product optimization, balancing sensory appeal and uniformity across sensory parameters.

3.1 Quality Analysis of JSC

Reasons for addition of fibre in baked products is to decrease calorie JSF, good source of dietary fibre, easy to process, can be incorporated into cookies without affecting eating quality. Inclusion of JSF in cookies gave an excellent eating quality in term of several sensory attributes (Butool *et al.,* 2015). The findings of the proximate analysis showed that the addition of JSF raised the amount of ash and crude fibre in JSC. The greater mineral content of the seed flour may be the cause of the high ash content. Owing to the high crude fibre content of the seeds, the amount of crude fibre got up. Furthermore, the inclusion causes the protein content level of JSC to decline considerably. The crude fibre level of bread is soared as a result of the JSF. Jack seed is used to the baked goods in order to boost their dietary fibre content because they are extremely low in it.

3.2 Comparative proximate composition of jack seed cookies vs. wheat cookies

3.2.1 Titratable Acidity

The TA value of 1.44% (fig.2) indicates the acidity of these cookies is not high and is less likely to cause discomfort in the digestion. Wheat biscuits are not usually very acidic. Given that it has low acidic value (1.44%), JSC is healthy and may be opt by acidic sensitive patients. Maintaining a low TA in food products can help extend their shelf life. The quality of the product is maintained and spoilage is prevented over time by manipulating the TA of the food (Wrolstad *et al.,* 2005).

3.2.2 Ash Content

The ash content of 3.12% (fig.2) in JSC highlights the presence of considerable amount of mineral content, as ash reflects the mineral content in a food product. Jack seeds are good source of essential minerals such as potassium**,** magnesium, and iron (Tharanathan *et al.*, 2003). Wheat flour has ash content about 1-2%, which is lower than that of Jack seeds. Despite whole wheat flour containing higher mineral levels, especially iron and magnesium, it still has lower ash content when compared to Jack seeds (Fazaeli *et al.*, 2018). Compared to traditional wheat cookies, the ash content is higher in JSC that may improve the electrolyte balance and bone health. It is an excellent source of magnesium that is essential in calcium absorption and preventing diseases like Osteoporosis (Maurya *et al.*, 2016).

ISSN: 2455-6939

Volume: 11, Issue: 04 "July-August 2025"

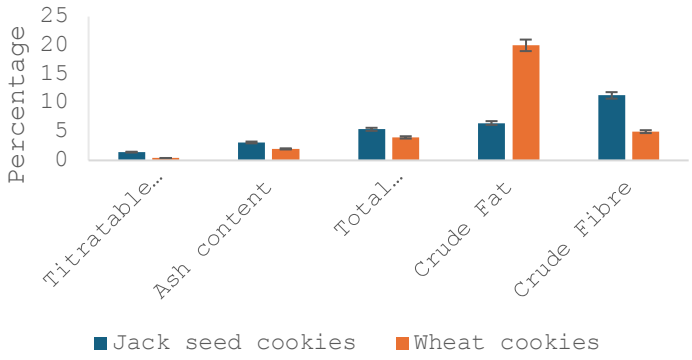

Fig. 2: Comparative proximate composition of jack seed cookies vs. wheat cookies

3.2.3 Protein Content

With 5.4% protein content (fig.2), jack seeds used in JSC contribute a moderate level of protein. Jack seeds are known for their protein content, which normally ranges from 5% to 10% on a dry weight basis (Tharanathan and Mahadevamma, 2003). Traditional wheat cookies generally have approximately 2-4% protein content, primarily derived from the wheat flour. This makes Jack seed cookies a better source of protein than most wheat cookies, offering a higher protein density in day-to-day uptake in regular diet. Jack seed cookies have a clear edge over wheat-based cookies in terms of protein content, making them a better choice for individuals looking to increase their protein intake without relying on animal-based lean protein sources. Vegans, who are looking for a lean protein source to be included in their diet, can make the most out of it.

3.2.4 Crude Fat

The crude fat content of JSC is relatively higher (21%) shown in fig. 2. which infers that JSC has higher calorific value and are calorie dense functional food. Addition of ingredients like binding agents along with the fat that is normally present in the Jack seeds causes a significant increase in the fat content of the cookies. Typically, the fat content of wheat cookies is around 10-20% which varies with the nature of the ingredients used in the cookie making. According to Fazaeli *et al.* (2018), the fat content in wheat cookies can range between 15-20% (Fazaeli and Moradi, 2018). While both Jack seed and wheat cookies contain significant fat, JSC are at the higher end of the fat content range.

3.2.5 Crude Fibre

The fibre content of 3.1% (fig.2) in JSC suggests a considerable inclusion of dietary fibre. Jack seeds are abundant in dietary fibre, which aids in digestion, beneficial for gut health and provides satiety (Muralikrishna and Narsinga Rao, 2005). According to Khan *et al.* (2012), the amount of fibre content present in wheat cookies may greatly vary with the type of flour that is used in the

ISSN: 2455-6939

Volume: 11, Issue: 04 "July-August 2025"

cookie making. Refined wheat flour has lower fibre content (about 1-2%) when compared to the whole wheat flour cookies may range from 3 to 5% fibre content (Khan *et al.,* 2012). JSC offers fibre content similar to that of whole wheat cookies and may be an excellent choice for individuals looking to include DF in their diet with low gluten content.

4. CONCLUSION

This study highlights the promising ability of JSF as a valuable ingredient in confectionaries and bakeries for cookie making. Jack seeds are fairly regarded and discarded as waste and possess immense nutritional qualities. Thus, it may be considered as a revolutionary step in food innovation. The prototypes of JSC varying in the proportion of jackfruit seed flour, wheat flour, rice flour and other ingredients were tested based on their compliance to 6 parameters of sensory attributes. The sensory evaluation, conducted based on panellist preferences on a five-point hedonic scale, unraveled that Trial 5, which is composed of JSF and wheat flour blend in the ratio 60:40, had the highest consumer acceptance among all the five prototype formulations made in the trials. This trial conquered the top mean scores for taste, texture, and appearance with very low standard deviation for the parameters indicating the promising nature of the formulation and consistency among the respondents in the sensory evaluation for the product. Furthermore, the study reports significant differences in sensory attributes like taste, sweetness, and texture across the five trials, emphasizing the importance of formulation adjustments to achieve optimal product characteristics. The cookies were at its best when JSF was used at the level of 60% of the recipe without negatively affecting consumer preference, indicating that the use of JSF could be a promising replacement of the age-old practice of adding wheat flour in the confectionary and baking industry. This approach not only reduces the waste of jack seeds but also enhances the nutritional value of the product. Further research could investigate shelf-life stability, consumer market testing and nutritional profiling of the product to further explore their market viability and to develop a novel and trailblazing healthy product from JSF. This research helps in reducing food waste and developing innovative, nutritious bakery products that can act as functional foods.

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