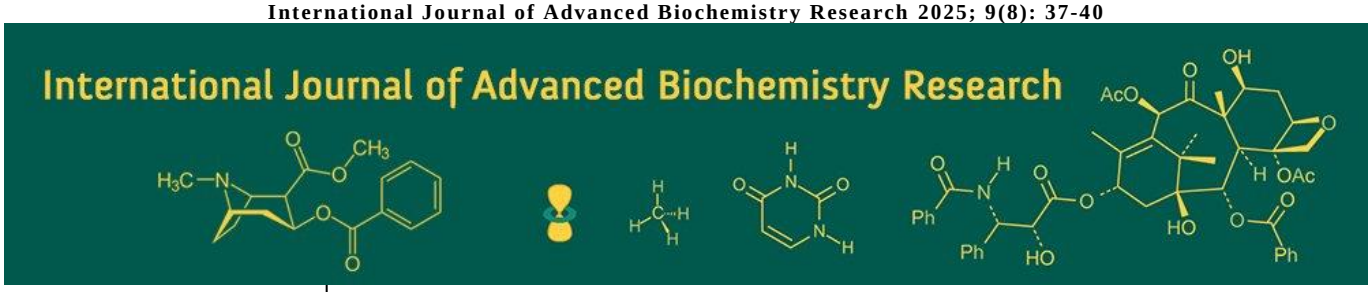

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Standardization and development of Kachori formulated with *Acetes* powder

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Abstract
The present study was undertaken to develop a value-added snack product by incorporating *Acetes* shrimp powder into a traditional Indian snack, Kachori, to enhance its nutritional profile and acceptability. *Acetes spp*., commonly known as paste shrimp, are small, protein-rich marine resources abundantly available along the Indian coast, particularly in Maharashtra and Gujarat. For the preparation of *Acetes*-based Kachori key ingredients such as the ratio of refined wheat flour to wheat flour and concentrations of red chilli powder, amchur (dry mango) powder, salt and *Acetes* powder were standardized. The standardization was based on organoleptic evaluation by a group of 10 trained panellists using a 9-point hedonic scale. The proximate composition of the standardized Kachori revealed 7.04±0.05% moisture, 17.01±0.03% protein, 20.66±0.01% fat, 1.98±0.01% ash and 53.30±0.05% carbohydrate, indicating a balanced nutritional profile. The study demonstrated the potential of *Acetes* powder in developing affordable, protein-rich, ready-to-eat seafood-based snack with good nutritional value.

Keywords: *Acetes* powder, Kachori, standardization, organoleptic evaluation and proximate composition

Introduction
In 2022, global fisheries and aquaculture production reached 223.2 million tonnes, comprising 185.4 million tonnes of aquatic animals and 37.8 million tonnes of algae, with 89% of aquatic animal production utilized for human consumption, amounting to an estimated 20.7 kg per capita (FAO, 2024) [6]. In 2023, marine fish landings along mainland India were estimated at 3.53 million tonnes, with non-penaeid prawns comprising 2.11 lakh tonnes (5.98%) of the total catch. Notably, non-penaeid prawns, primarily small shrimps, reached their highest landings in Gujarat over the past three decades, total 1.70 lakh tonnes. Maharashtra reported a 24.3% increase in landings compared to 2022, with non-penaeid prawns contributing 0.23 lakh tonnes (CMFRI, 2024) [4].

Non-penaeid prawns make up around 20% of the total marine prawn catch in India, with *Acetes spp*. Accounting for approximately 98% of this category. Commonly referred to as "paste shrimp," they belong to the family Sergestidae. It is small in size, widely distributed across various regions worldwide and found along the coasts of many countries bordering the Indian Ocean. In India, the majority of *Acetes* landings occur along the northwest coast, particularly in Gujarat and Maharashtra, where the prawn is locally referred to as 'Jawla'. Smaller quantities are also caught along the coasts of Andhra Pradesh, West Bengal and the Andaman & Nicobar Islands. This prawn reaches up to 40 mm in length and weighs between 0.2 and 0.5 grams. It is an epipelagic, planktonic species that forms large shoals in surface waters. The catch includes four species: *Acetes indicus*, *Acetes johni*, *Acetes sibogae*, and *Acetes japonicus*. The fresh consumption of *Acetes* is quite limited. Locals often use it to make a type of curry or prepare it with Bengal gram powder, usually served with rice. Dried *Acetes* is not widely consumed in coastal regions, except during the off-season when fresh fish is scarce. At such times, it is used in chutneys, curries and as a condiment or seasoning. In the Andaman and Nicobar Islands, it is traditionally used in the preparation of a dish called 'Nappi' (Zynudheen *et al*. 2004) [14].

High-quality dried *Acetes*, prepared under hygienic conditions, is golden yellow, crispy and has a distinct flavour. In inland markets, where fresh fish is less accessible, the demand for dried *Acetes* is very high (Zynudheen *et al.* 2004) [14]. Traditionally sun-dried *Acetes* contains approximately 19% moisture, 48% crude protein, 16% ash, 3.6% crude fat and 10% chitin. It is rich in essential amino acids and significant fatty acids such as 9,12-octadecadienoic acid (17.08%), DHA (15.69%), EPA (13.45%) and docosanoic acid (11.75%). It also contains minerals like phosphorus, calcium, potassium, magnesium, sodium and iron (Balange *et al.* 2017) [3].

Fishery products are perishable and require careful preservation methods such as temperature control, water activity reduction and microbial load control. Value addition in fish processing involves enhancing usability, culinary attributes and economic value often resulting in ready-to-eat or ready-to-prepare items. These innovations improve convenience and meet changing consumer demands (Datta, 2015) [5]. The growing need for shelf-stable, protein-rich, easy-to-prepare foods is driven by lifestyle changes and the increase in double-income households (Mishra *et al.* 2017) [9]. Snack foods, being durable and appealing, are ideal to meet these needs (Poodari *et al.* 2018) [10].

Kachori is a traditional snack widely consumed in Rajasthan, Uttar Pradesh, Madhya Pradesh and other parts of North India. It consists of a round, flattened dough filled with spiced lentil or gram flour mixtures. Fish and shellfish are valuable sources of protein, fat, essential amino acids and micronutrients. To enhance income and diversify products, incorporating marine ingredients like *Acetes* into value-added snacks such as fish Kachori is promising (Solanki *et al.* 2019) [11]. This study focuses on formulating a nutrient-enhanced Kachori using *Acetes* powder, aiming to improve its protein content and overall nutritional value while retaining sensory appeal.

Materials and Methods Procurement of *Acetes*

Fresh, good-quality sun dried *Acetes* with an attractive shiny appearance, golden-yellow colour, firm and crispy texture and a pleasant aroma was collected from a dry fish vendor and local market in Ratnagiri, Maharashtra.

Procurement of ingredients

Good-quality locally available ingredients such as spices and flours were brought from the local market and used for product preparation.

Preparation of *Acetes* powder

Fresh sun dried *Acetes* was brought from the market to the lab and weighed. It was then cleaned sieved by removing dirt and unwanted materials. Next, the *Acetes* was dried in an oven at 40-45°C for 2 hours and ground into powder using domestic grinder. The weights of both fresh dry *Acetes* and powdered *Acetes* were measured using an electronic balance. The procedure was repeated to calculate the average percentage yield of *Acetes* powder.

Standardization of Kachori made from *Acetes*

For the preparation of Kachori, a tentative recipe was selected based on the methods described by Agrawal and Sengupta (2014) [1] with slight modifications. First the moong dal was soaked in water for 10-15 minutes and then drained completely. After that it was ground into a paste and then roasted in oil along with *Acetes* powder and spices such as cumin, coriander, red chilli powder, amchur powder, garam masala, turmeric and salt. The mixture was cooked until well-blended and suitable for stuffing. To make the outer covering, both refined wheat flour and whole wheat flour were mixed and kneaded into a soft dough using a small amount of oil. The dough was then covered with a muslin cloth and left to rest. Small portions of the dough were rolled out and a portion of the prepared filling was placed in the center of each. The edges were sealed properly and the filled dough was shaped into small round or circular Kachoris. These were deep-fried in hot oil until they turned golden brown and were cooked evenly from the inside.

For the development of *Acetes*-based Kachori, standardization of key ingredients was essential to achieve the most acceptable formulation in terms of taste, texture and overall quality. The ingredients selected for standardization included the ratio of refined wheat flour (Maida) to wheat flour in the dough and the concentrations of red chilli powder, amchur (dry mango) powder, salt and *Acetes* powder by replacing green gram in the stuffing. These were considered crucial in influencing the sensory attributes of the final product. The ingredients that were kept constant in all formulations included turmeric powder (4 g), garam masala (8 g), coriander powder (12 g), cumin powder (8 g), oil (20 ml) and other processing parameters related to preparation and frying.

For the standardization of the flour ratio, Kachori dough was prepared using three different combinations of refined wheat flour and wheat flour: 60:40 (D1), 50:50 (D2) and 40:60 (D3), keeping all other ingredients constant. The purpose was to determine the most suitable flour blend that would provide the desired texture and structure in the final product.

For standardization of different spices in the stuffing first red chilli powder was tested at levels of 12 g (C1), 14 g (C2), 16 g (C3) and 18 g (C4) to assess its effect on the spiciness and flavour balance of the stuffing. Amchur powder was added at concentrations of 8 g (M1), 10 g (M2), 12 g (M3) and 14 g (M4) to enhance the tanginess and taste profile as well as salt was incorporated at varying levels of 2.5 g (S1), 3.0 g (S2), 3.5 g (S3) and 4.0 g (S4). The *Acetes* powder was incorporated into the stuffing in different percentages by replacing green gram such as: 0% (AP1), 10% (AP2), 20% (AP3), 30% (AP4).

Organoleptic evaluation

Each formulation was subjected to organoleptic evaluation by a group of 10 trained panellists using a 9-point hedonic scale. Sensory attributes such as appearance, colour, taste, texture, odour and overall acceptability were recorded. Based on the scores obtained, the most acceptable concentration of each ingredient was selected for the final standardized recipe.

Proximate composition

The proximate composition, including moisture, protein, fat, ash and carbohydrate content, was estimated using standard methods as described by AOAC (2005) [2].

Statistical analysis

Statistical analysis was carried out using appropriate methods as described by Snedecor and Cochran (1967) [12]. To assess the standardization of different ingredients, one-way ANOVA was used to determine significant differences

among treatments, followed by post-hoc analysis using the Tukey test.

Results and Discussion

Proximate composition of dried *Acetes*

Fresh dried *Acetes* from market contained approximately 18.64±0.02% moisture, 48.59±0.01% protein, 3.61±0.01% fat, 14.12±0.01% carbohydrate and 15.04±0.02% ash. Balange *et al.* (2017) [3] reported that dried *Acetes* contained around 19.00% moisture, 48.29% crude protein, 16.05% ash and 3.62% crude fat. As per the findings of Mahakal *et al.* (2017) [8], dried *Acetes* showed nutritional contents of 12.41% moisture, 63.56% protein, 3.86% fat, 4.66% carbohydrates and 12.81% ash. Sridhar (1983) [13] observed moisture, protein, fat and ash levels at 15.55%, 63.76%, 6.03% and 13.62%, while Jagushte (1989) [7] noted values of 9.30%, 50.40%, 4.80% and 18.90% respectively. Zynudheen *et al.* (2004) [14] also reported 10.70% moisture, 61.90% protein, 3.80% fat and 11.90% ash.

Yield (%)

The *Acetes* was first cleaned and sieved to remove dirt, small fishes and other impurities. After oven drying at 40-45°C for 2 hours it showed a yield of about 72.1±0.04%. Once it was powdered the final yield came to around 65.21±0.24%. As per the findings of Jagushte (1989), the total yield from whole *Acetes* after drying and powdering was noted to be 21.56%.

Standardization of Kachori made from *Acetes*

A tentative recipe reported by Agrawal and Sengupta (2014) [1] was used with slight modifications to standardize the ingredients for *Acetes*-based Kachori. The refined wheat flour to wheat flour ratio of 50:50 (D2) was selected for preparing the Kachori dough as it gave the best texture and overall appearance. The dough was neither too soft nor too hard, making it suitable for Kachori preparation. In the stuffing, red chilli powder at 16 g (C3) was preferred for its proper level of spiciness, which also matches the quantity used by Agrawal and Sengupta (2014) [1].

Amchur powder at 12 g (M3) gave the right amount of tangy taste and 3.5 g (S3) of salt was found to be ideal for seasoning. Among all the treatments, the sample containing 20% (14g) of *Acetes* powder (AP3) was found to be the most acceptable in terms of taste, aroma, texture and overall appeal. The panellists noted that this concentration offered a pleasant fishy flavour. At higher levels, the fishy and slightly salty taste became more dominant. On the other hand, the samples with lower concentrations of *Acetes* powder were considered mild and lacked the seafood flavour. A related study by Solanki *et al.* (2019) involved the incorporation of 20% croaker fish powder in a Kachori, which was also found acceptable. Selected treatments were finalized based on sensory scores from trained panellists using a 9-point hedonic scale and showed significant differences ($p<0.05$) from other treatments, as confirmed by one-way ANOVA and Tukey's post hoc test.

Proximate composition of standardized Kachori from *Acetes*

The moisture, protein, fat, ash and carbohydrate contents of the standardized Kachori were recorded as 7.04 ±0.05%, 17.01±0.03%, 20.66±0.01%, 1.98±0.01% and 53.30±0.05%, respectively. In a similar study, Solanki *et al.* (2020) [11] developed a fish-based snack product (Fish Kachori) from lesser tiger tooth croaker (*Otolithes cuvieri*) and reported a proximate composition of 9.92±0.08% moisture, 21.38±0.87% protein, 19.81±0.29% fat, 2.95±0.05% ash and 44.92±0.08% carbohydrate. Poodari *et al.* (2019) [10] carried out a study on the development of shelf stable spent hen meat Kachori incorporated with prebiotic fibers and reported a proximate composition of 21.99±0.20% moisture, 22.35±0.29% protein, 20.72±0.09% fat and 3.01±0.04% ash.

Table 1: Proximate composition of dried *Acetes*

Parameter	Quantity (%)
Moisture	18.64±0.02
Protein	48.59±0.01
Fat	3.61±0.01
Ash	15.04±0.02
Carbohydrate	14.12±0.01

Table 2: Yield (%) of *Acetes* powder

Form of *Acetes*	Yield (%)
Fresh dried *Acetes* from market	100
Oven dried *Acetes*	72.1±0.04
Acetes powder	65.21±0.24

Table 3: Mean sensory scores of different ratios of refined wheat flour to wheat flour for the preparation of Kachori dough

Sr. No.	Sensory characteristics	D1 (60:40)	D2 (50:50)	D3 (40:60)
1.	Appearance	7.40±0.84^{a}	8.20±0.63^{a}	7.10±0.74^{a}
2.	Colour	7.80±0.91^{a}	8.30±0.48^{a}	7.50±0.84^{a}
3.	Odour	7.90±0.99^{ab}	8.40±0.51^{b}	7.60±0.51^{a}
4.	Texture	7.60±0.97^{a}	8.00±0.67^{a}	7.40±0.51^{a}
5.	Taste	7.60±0.96^{ab}	8.30±0.48^{b}	7.30±0.67^{a}
6.	Overall acceptability	7.80±0.78^{a}	8.30±0.48^{a}	7.50±0.97^{a}

Means ± SD a-b in the same row followed by different superscripts are significantly different ($p<0.05$) (n=10).

Table 4: Mean sensory scores of Kachoris made up with different concentrations of red chilli powder for the preparation of stuffing

Sr. No.	Sensory characteristics	C1	C2	C3	C4
1.	Appearance	8.00±0.94^{a}	8.10±0.73^{a}	8.40±0.51$_{a}$	8.00±0.66^{a}
2.	Colour	7.90±0.87^{a}	8.00±0.81^{a}	8.10±0.56$_{a}$	7.90±0.73^{a}
3.	Odour	7.60±0.69^{ab}	7.90±0.56^{ab}	8.30±0.67^{b}	7.00±0.94^{a}
4.	Texture	8.00±0.47^{a}	8.10±0.87^{a}	8.20±0.78^{a}	7.90±0.87^{a}
5.	Taste	7.70±0.94^{ab}	8.00±0.66^{ab}	8.50±0.70^{b}	7.30±0.67^{a}
6.	Overall acceptability	7.40±0.69^{a}	7.90±0.56^{ab}	8.40±0.69^{b}	7.10±0.87^{a}

Table 5: Mean sensory scores of Kachoris made up with different concentrations of amchur (dry mango) powder for the preparation of stuffing

Sr. No.	Sensory characteristics	M1	M2	M3	M4
1.	Appearance	8.10±0.56^{a}	8.20±0.78^{a}	8.40±0.51^{a}	8.00±0.47^{a}
2.	Colour	8.00±0.81^{a}	8.10±0.87^{a}	8.20±0.91^{a}	8.10±0.33^{a}
3.	Odour	7.60±0.51^{a}	8.00±0.66^{a}	8.30±0.67^{a}	7.40±0.96^{a}
4.	Texture	8.00±0.78^{a}	8.20±0.42^{a}	8.30±0.21^{a}	8.10±0.99^{a}
5.	Taste	7.80±0.78^{ab}	8.00±0.81^{ab}	8.40±0.69^{b}	7.10±0.87^{a}
6.	Overall acceptability	7.60±0.51^{a}	7.90±0.56^{a}	8.30±0.67^{b}	7.30±0.82^{a}

Means ± SD a-b in the same row followed by different superscripts are significantly different ($p<0.05$) (n=10).

Table 6: Mean sensory scores of Kachoris made up with different concentrations of salt for the preparation of stuffing

Sr. No.	Sensory characteristics	S1	S2	S3	S4
1.	Appearance	8 .10±0.56^{a}	8.00±0.87^{a}	8.20±0.91^{a}	6.90±0.73^{a}
2.	Colour	8.10±0.87^{a}	8.10±0.73^{a}	8.30±0.67^{a}	8.00±0.81^{a}
3.	Odour	7.60±0.84^{a}	7.90±0.87^{a}	8.40±0.69^{a}	7.40±0.84^{a}
4.	Texture	8.00±0.66^{a}	8.10±0.56$_{a}$	8.30±0.67^{a}	8.00±0.66^{a}
5.	Taste	7.20±0.78^{ab}	7.70±0.82^{ab}	8.50±0.52^{b}	6.70±0.82^{a}
6.	Overall acceptability	7.70±0.83^{ab}	7.90±0.56^{ab}	8.50±0.52^{b}	7.20±0.63^{a}

Means ± SD a-b in the same row followed by different superscripts are significantly different (p<0.05) (n=10).

Table 7: Mean sensory scores of Kachoris made up with different concentrations of *Acetes* powder by replacing green gram for the preparation of stuffing

Sr. No.	Sensory characteristics	AP1 (0%)	AP2 (10%)	AP3 (20%)	AP4 (30%)
1.	Appearance	7.90±0.73^{a}	8.00±0.47^{a}	8.20±0.63^{a}	7.80±0.78^{a}
2.	Colour	8.00±0.81^{a}	8.10±0.56^{a}	8.30±0.48^{a}	7.90±0.73^{a}
3.	Odour	7.80±0.78^{ab}	8.00±0.66^{ab}	8.40±0.51^{b}	7.40±0.96^{a}
4.	Texture	8.00±0.94^{a}	8.10±0.31^{a}	8.10±0.73^{a}	7.90±0.73^{a}
5.	Taste	7.40±0.96^{a}	7.70±0.67^{a}	8.00±0.47^{a}	7.10±0.78^{a}
6.	Overall acceptability	7.30±0.67^{ab}	7.90±0.31^{ab}	8.30±0.67^{b}	7.20±0.91^{a}

Means ± SD a-b in the same row followed by different superscripts are significantly different (p<0.05) (n=10).

Conclusion

The present study successfully developed a value-added Kachori by incorporating *Acetes* powder. Standardization of key ingredients was achieved through sensory evaluation. The final product showed good acceptability in terms of taste, texture and overall acceptability. The addition of *Acetes* powder enhanced the product's nutritional value, especially in terms of protein content and shows potential for utilizing marine resources in the development of value-added snack products.

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