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Development and quality evaluation of chicken meat dip fortified with vitamin A and calcium

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Abstract

The present study aimed to develop a nutritionally enriched chicken meat dip incorporated with carrot purée and sesame seed powder and to evaluate its quality characteristics. Two formulations were prepared: a control (T₁) without sesame seed powder and a fortified treatment (T₂) with sesame seed powder as a natural source of calcium. Both formulations were analyzed for proximate composition and sensory attributes. The moisture content ranged from 70.84% to 74.84%, while crude protein content varied between 13.67% and 13.83%, indicating that the product is a good source of high-quality protein. Fat content was significantly higher in T₂ (10.39%) compared to T₁ (8.45%), due to sesame seed incorporation. Ash and calcium contents were also higher in T₂, reflecting improved mineral composition, whereas vitamin A content (185 µg) remained similar in both treatments due to carrot purée addition. The incorporation of plant-based ingredients contributed to dietary fibre enrichment, enhancing the functional value of the product. Sensory evaluation revealed that both formulations were well accepted, with scores ranging from 7.21 to 7.65 on an 8-point hedonic scale. However, T₂ recorded significantly higher scores for appearance, flavour, consistency, taste, and overall acceptability. The improved sensory quality of T₂ may be attributed to enhanced fat content, emulsion stability, and the flavour-enhancing properties of sesame seeds, while carrot purée contributed to improved colour and antioxidant potential.

Keywords: Chicken meat, dip, nutritional and sensory quality, carrot and vitamin A, sesame seed and calcium

Introduction

The global demand for convenient, ready-to-eat (RTE) and ready-to-cook (RTC) meat products has increased significantly in recent years due to changing lifestyles, urbanization and consumer preference for nutritious and functional foods. Among various meat sources, chicken meat is widely preferred because of its high biological value protein, low fat content, desirable fatty acid profile and absence of religious restrictions. Furthermore, chicken meat is highly suitable for the development of emulsion-based and spreadable products such as dips, pâtés and spreads, which offer better palatability, convenience and value addition (Petracci *et al.*, 2015; Toldrá & Reig, 2016) [25, 32].

Despite its nutritional advantages, conventional meat products are often criticized for lacking dietary fibre and bioactive compounds, which are essential for promoting human health. Therefore, recent research has focused on the incorporation of plant-based functional ingredients into meat products to improve their nutritional profile, technological properties, and shelf life. Such functional meat products not only enhance consumer acceptability but also contribute to the development of healthier meat alternatives (Bhat *et al.*, 2021; Lorenzo *et al.*, 2018) [3, 17].

Carrot (*Daucus carota*) is an important root vegetable recognized for its high content of dietary fibre, β-carotene, vitamins (A, C, and K), minerals and natural antioxidants. The incorporation of carrot puree or fibre into meat products has been shown to improve water-holding capacity, emulsion stability, and cooking yield while reducing fat content and lipid oxidation. Additionally, carrot contributes to improved colour and sensory attributes due to the presence of carotenoid pigments (Kumar *et al.*, 2015; Sharma *et al.*, 2020) [14, 28]. Studies have

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demonstrated that the inclusion of vegetable fibres such as carrot in meat formulations enhances functional properties and provides health benefits, including improved digestion and reduced risk of chronic diseases (Lorenzo *et al.*, 2018) [17].

Sesame seeds (*Sesamum indicum*) are another nutritionally rich ingredient widely valued for their high levels of unsaturated fatty acids, protein, dietary fibre, vitamins and lignans such as sesamin and sesamol. These lignans possess strong antioxidant properties, which help in delaying lipid oxidation and improving the shelf life of meat products. The incorporation of sesame seeds or sesame-derived products into meat formulations has been reported to enhance flavour, improve oxidative stability, and contribute to a healthier lipid profile (Pathak *et al.*, 2017; Elleuch *et al.*, 2011) [24, 7]. Moreover, sesame seeds act as natural antioxidants and functional additives, reducing the need for synthetic preservatives in processed meat products.

The development of a chicken meat dip incorporated with carrot puree and sesame seeds powder represents a novel approach to producing a functional, nutritionally enriched RTE product. Such products combine the high-quality protein of chicken meat with the dietary fibre and antioxidants from plant sources, thereby meeting the growing consumer demand for health-oriented foods. Additionally, the use of natural ingredients such as carrot and sesame seeds can improve the physicochemical properties, sensory characteristics and storage stability of meat dips. This approach aligns with current trends in clean-label product development, where natural additives are preferred over synthetic ones (Bhat *et al.*, 2021; Sharma *et al.*, 2020) [3, 28].

Therefore, the present study was undertaken to develop a chicken meat dip incorporated with carrot puree and sesame seed powder, with the objective of enhancing its functional and nutritional properties. The developed product was systematically evaluated for its nutritional composition and sensory attributes to assess its suitability as a value-added, health-oriented meat product.

Materials and Methods

The chicken meat dip fortified with vitamin A and calcium was prepared following a standardized procedure. Fresh raw materials such as chicken, carrot and tomato were procured from the local market and thoroughly cleaned and washed. The chicken was washed, boiled for 10–15 minutes to reach the internal temperature of 75 °C, cooled and then minced to obtain a uniform texture. Carrots were washed, peeled, cut into small pieces and blanched at 90 °C for 3–5 minutes, followed by cooling and grinding to form a smooth puree. Similarly, tomatoes were washed, blanched, peeled and ground into a puree. Sesame seeds were cleaned, dry roasted to enhance flavor, cooled, and ground into a fine powder.

For the preparation of the dip, oil was heated and garlic powder was added and sautéed to develop flavour. Cooked minced chicken meat was then added and mixed thoroughly, followed by cooking for 3–5 minutes. Subsequently, tomato puree and carrot puree were incorporated and cooked for 1–3 minutes. Sesame seed powder along with salt, sugar, pepper, and chilli powder were added for fortification and seasoning. The mixture was then cooked on a low flame for 5–7 minutes until a semi-solid dip consistency was achieved. The prepared dip was allowed to cool to room temperature, packed in sterilized airtight containers and stored under refrigerated conditions (4 ± 1 °C).

In the present study, two different formulations of chicken meat dip were developed to evaluate the effect of calcium fortification through sesame seed incorporation, while maintaining vitamin A enrichment through carrot puree. Both treatments were prepared using the same base ingredients and standardized processing conditions to ensure uniformity in preparation and allow for meaningful comparison. Treatment 1 (T₁) consisted of chicken meat dip formulated with cooked minced chicken, carrot puree (as a natural source of vitamin A), tomato puree, oil, garlic powder, salt, sugar, pepper, and chilli powder. This formulation did not include sesame seed powder and served as the control for evaluating the impact of calcium enrichment. Treatment 2 (T₂) contained all the ingredients used in Treatment 1, with the addition of roasted and finely ground sesame seed powder as a natural source of calcium. The incorporation of sesame seed powder was intended to enhance the mineral content of the product, particularly calcium, while also contributing to flavor, texture, and overall nutritional quality. During the processing of chicken meat dip, the required quantity of potable water was added. The final products were evaluated for their nutritional composition and sensory attributes. Flow Chart for Preparation of Chicken Meat Dip Fortified with Vitamin and Calcium shown in Figure 1 and product in Figure 2.

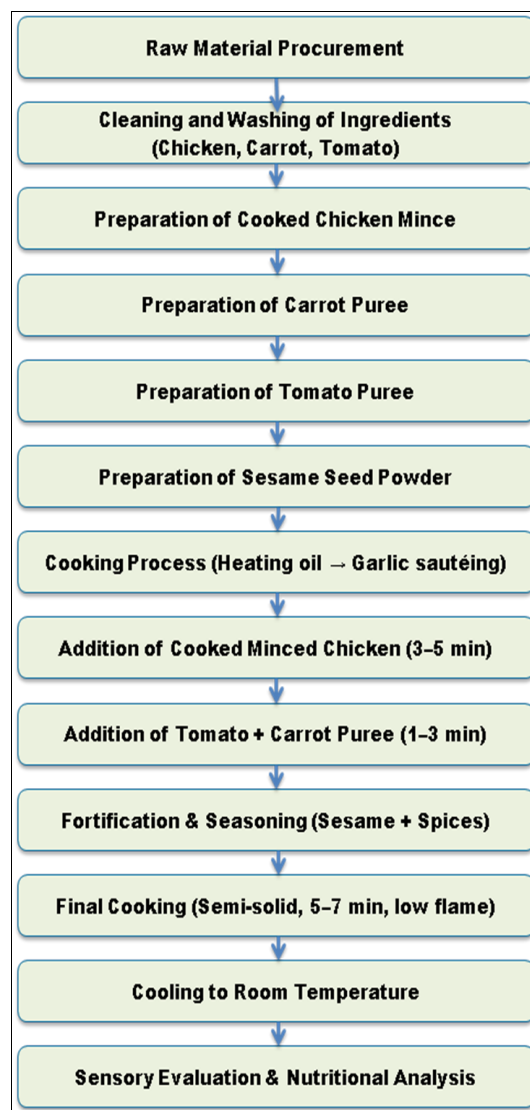


Fig 1: Flow Chart for Preparation of Chicken Meat Dip Fortified with Vitamin and Calcium



Fig 2: Developed Chicken Meat Dip Fortified with Vitamin A and Calcium

Parameter Assessed

Proximate composition

The proximate composition of developed chicken meat dip was determined as per the methods recommended by AOAC (2016) [2]. The crude protein content was determined by the Kjeldahl method and the crude fat content was determined by the Soxhlet method. The total ash content was determined by ashing the samples overnight at 550 °C. Moisture content was determined by drying the samples overnight at 105 °C.

Calcium content

The Calcium content of developed chicken meat dip samples as determined as per the methods recommended by AOAC (2016) [2]. Calcium was estimated by the permanganimetric titration method.

Vitamin A

The Vitamin A content of developed chicken meat dip samples as determined as per the methods recommended Raghuramulu *et al.* (1983) [26] with slight modification.

Sensory evaluation

Sensory evaluation of the developed chicken meat dip was assessed by semi-trained panelists at the Department of Livestock Products Technology (Meat Science), Veterinary College and Research Institute, Namakkal - 637 002, using an eight-point hedonic scale. Panelists were instructed to cleanse their mouths with water between sample assessments (Keeton, 1983) [13].

Results and Discussion

Treatment 1 (T₁) consisted of chicken meat dip prepared with cooked minced chicken, carrot puree, tomato puree, oil, and seasoning ingredients, without the addition of sesame seed powder, and served as the control. Treatment 2 (T₂) included the same ingredients as T₁, with the addition of roasted sesame seed powder as a source of calcium to enhance nutritional quality. Both formulations were evaluated for proximate composition and sensory attributes.

Proximate Composition of Fortified Chicken Meat Dip

The proximate composition, including moisture, protein, fat, ash, and carbohydrate content, was determined using standard methods, and the results are presented in Table 1.

Table 1: Proximate Composition of Fortified Chicken Meat Dip

Parameters	T ₁	T ₂
Moisture (%)	74.84±0.11 ^b	70.84±0.08 ^a
Crude Protein (%)	13.83±0.14 ^a	13.67±0.10 ^b
Ether Extract (%)	8.45±0.12 ^a	10.39±0.08 ^b
Total Ash (%)	1.73±0.06 ^a	1.95±0.04 ^b
Crude fibre (%)	1.56±0.10 ^b	1.60±0.11 ^a
Calcium (mg)	0.08±0.10 ^a	0.17±0.12 ^b
Vitamin A (µg/100g)	185 ±0.05 ^a	185 ±0.50 ^b
Gross Energy (kcal/100g)	154.10±0.10 ^a	177.10±0.12 ^b

T₁- without sesame seed powder and T₂- with sesame seed powder

Mean ± SE with same superscript within classes do not differ significantly ($p > 0.05$). n =6 for each treatment

Moisture Content

The moisture content of the developed Chicken Meat Dip formulations ranged from 74.84% in T₁ to 70.84% in T₂. The significantly higher moisture content observed in T₁ can be attributed to its lower level of oil incorporation, whereas the increased oil addition in T₂ resulted in a dilution effect, thereby proportionally reducing the water fraction of the formulation. This inverse relationship between fat and moisture content is commonly reported in emulsion-type and spreadable meat products.

Fresh raw chicken generally contains approximately 72–75% moisture (Lawrie & Ledward, 2014) [16]. The moisture level of the developed dip is comparable to raw chicken, indicating that processing and fortification did not drastically reduce inherent water content.

In comparison, plant-based dips such as chickpea- and legume-based formulations generally exhibit moisture contents in the range of 63–66%, depending on ingredient composition and processing conditions (Makhloufi & Yamani, 2024) [18]. The comparatively higher moisture content of the developed Chicken Meat Dip is likely to

enhance spread ability, mouthfeel and softness, attributes desirable in dip-type products. However, elevated moisture levels may also increase water activity, thereby predisposing the product to microbial proliferation. Consequently, refrigerated storage is essential to ensure microbiological safety and to extend the shelf life of the product.

Crude Protein Content

The crude protein content of the developed chicken meat dip formulations ranged from 13.83% in T₁ to 13.67% in T₂. The marginal reduction observed in T₂ may be attributed to a dilution effect resulting from sesame seed powder incorporation, which proportionally reduces the protein concentration on a wet-weight basis.

The primary protein source in the developed dip is cooked minced chicken, which is well recognized for its high biological value protein, excellent digestibility, and balanced essential amino acid profile. Raw chicken meat typically contains 18–20% crude protein (Lawrie & Ledward, 2014) [16] and its superior nutritional quality has been well documented (Muthulakshmi *et al.*, 2021) [23].

When compared with plant-based dip products, the protein content of the developed Chicken Meat Dip was considerably higher. Makhoulfi and Yamani (2024) ^[18] reported that legume-based dips generally contain 6–10% protein, depending on the type of pulse and formulation parameters. Similarly, Jadayil *et al.* (2024) ^[12] observed protein contents ranging from 7.2% to 9.4% in fresh-made and commercially canned chickpea and broad bean dips produced in Jordan. These lower values were attributed to higher moisture content and the predominance of carbohydrate-rich legume matrices. In contrast, the chicken meat based dip developed in the present study provided approximately 1.5–2 times higher protein content than chickpea- and broad bean-based dips reported in the literature. Beyond quantity, the quality of protein is also superior in chicken meat, owing to its balanced essential amino acid profile and higher digestibility. From a nutritional and functional perspective, the developed chicken meat dip offers a protein-dense alternative to conventional legume-based dips, with the added advantage of animal-derived high-quality protein. The incorporation of plant ingredients such as carrot and sesame seed powder further enhances the micronutrient profile without substantially compromising protein density. Therefore, the present findings establish the developed product as a protein-enriched functional meat-based dip, with clear nutritional superiority over commonly consumed legume-based dip formulations.

Crude Fat Content

The crude fat content of the developed chicken meat dip formulations increased from 8.45% in T₁ to 10.39% in T₂, corresponding directly to the variation in oil incorporation levels. The higher fat content observed in T₂ reflects a formulation-induced increase rather than intrinsic variation in meat fat, which is consistent with trends reported for processed and emulsion-type meat products.

When compared with plant-based dip formulations, the fat content of the developed Chicken Meat Dip is within an acceptable and nutritionally relevant range. Makhoulfi and Yamani (2024) ^[18] reported fat contents of 6–10% in legume-based dips, largely derived from added vegetable oils and natural seed lipids. Similarly, Jadayil *et al.* (2024) ^[12] observed fat levels ranging from 6.8% to 9.6% in fresh and commercially processed chickpea and broad bean dips. Although the fat content of T₂ slightly exceeds these values, it remains within the moderate-fat category, particularly when considered alongside its higher protein density and functional formulation.

Recent studies have also explored the use of sesame seed as a functional fat replacer in meat products. Studies such as “Influence of incorporation of ground sesame seed as fat replacer on the functionality of spent broiler breeder hen chicken sausages” and “Efficiency of sesame seeds as fat replacer to develop functional chicken sausage” have demonstrated that sesame seed incorporation can partially replace animal fat while improving water-holding capacity, emulsion stability, and overall product functionality. Sesame seeds are rich in unsaturated fatty acids, dietary fibre, and bioactive compounds, which contribute to improved nutritional quality without compromising sensory attributes.

From a technological and sensory standpoint, fat plays a critical role in determining product quality and consumer acceptability. Increased fat content contributes to improved mouthfeel, lubrication and flavour release, enhancing overall palatability. These functional roles of fat likely explain the

higher sensory acceptability scores observed in Treatment 2, as fat-rich formulations are known to provide a smoother texture and enhanced flavour perception in dip-type products.

Crude Fibre Content

The crude fibre content of the developed Chicken Meat Dip formulations ranged from 1.73% in T₁ to 1.95% in T₂, with only marginal variation between treatments. The slightly higher fibre content observed in T₂ may be attributed to differences in ingredient proportions and formulation consistency.

Chicken meat inherently contains negligible dietary fibre. Therefore, the fibre content observed in the developed dip can be entirely attributed to the incorporation of plant-based ingredients, namely carrot purée and sesame seed powder. Biochemically carrot is a rich source of β -carotene, fiber and many essential micronutrients and functional ingredients. The presence of high concentrations of carotenoids, especially β -carotene in carrot roots make them to inhibit cancers, free radical scavengers, anti-mutagenic and immunoenhancers. (Sharma *et al* 2024) ^[29], Sesame seeds are nutrient-dense powerhouses, offering roughly 50–57g of total fat (mainly healthy unsaturated fats), 18g of protein, and 12–17g of dietary fiber per 100g. They are exceptionally high in calcium (up to 1450mg/100g), magnesium, iron, phosphorus, and zinc, supporting bone health, energy production, and immunity. while sesame seeds contain appreciable amounts of both soluble and insoluble fibre fractions, contributing to gastrointestinal health (Elleuch *et al.*, 2011) ^[7].

In comparison, chickpea-based dips generally contain approximately 2–3% crude fibre, whereas other legume-based dips may exhibit fibre contents ranging from 3–5%, depending on pulse type and concentration (Makhoulfi & Yamani, 2024) ^[18]. Similarly, Jadayil *et al.* (2024) ^[12] reported higher fibre levels in chickpea and broad bean dips, reflecting the inherently high fibre content of legumes. Although the fibre content of the developed Chicken Meat Dip is slightly lower than that of legume-based dips, the fortification strategy employed in the present study successfully introduced dietary fibre into a meat-based product, which would otherwise be devoid of fibre. This represents a significant nutritional enhancement, as meat products traditionally lack dietary fibre. From a functional and nutritional standpoint, the inclusion of dietary fibre is associated with improved digestive health, modulation of gut function, and enhanced satiety. Therefore, even moderate levels of fibre incorporation substantially improve the functional value of the developed Chicken Meat Dip. The present findings demonstrate that the combination of animal-based protein with plant-derived fibre sources can result in a balanced, functional meat product with added health benefits.

Total Ash Content

The ash content of the developed chicken meat dip formulations ranged from 1.46% to 1.60%, indicating the presence of appreciable levels of mineral constituents in the product. The variation in ash content between treatments suggests that sesame seed powder incorporation had a significant effect on total mineral content.

The mineral content of the developed dip can be primarily attributed to the inclusion of sesame seed powder and chicken meat. Sesame seeds are well recognized for their high calcium content, along with other essential minerals, whereas chicken meat contributes important minerals such as phosphorus and iron, which play vital roles in bone health, energy

metabolism, and oxygen transport. The incorporation of sesame seed powder therefore enhanced the mineral density of the meat-based dip, contributing to its functional value. Comparable ash values have been reported for legume-based dips, which typically exhibit ash contents ranging from 1.5% to 1.8%, depending on formulation and raw material composition (Makhloufi & Yamani, 2024) ^[18]. The ash content observed in the present study falls within this reported range, indicating that the mineral content of the developed Chicken Meat Dip is comparable to commonly consumed plant-based dips, despite differences in ingredient composition.

Calcium content

The calcium content of the developed chicken meat dip formulations was found to be 0.08% in T₁ and 0.17% in T₂, indicating a marked increase with formulation modification. The higher calcium content observed in T₂ may be attributed to a concentration effect due to reduced moisture content, as well as the relative increase in calcium-rich ingredients in the formulation.

Chicken meat is generally considered a poor source of calcium, contributing minimally to dietary calcium intake. Studies by Muthulakshmi *et al.* (2021; 2022) ^[23, 21, 22] have demonstrated that while different cooking methods influence the retention of nutrients in chicken meat, the intrinsic calcium content remains relatively low compared to other minerals such as phosphorus and iron. Therefore, the enhanced calcium content observed in the present study is primarily due to fortification through plant-based ingredients, particularly sesame seed powder.

Sesame seeds are well recognized as a calcium-rich oilseed, containing significant levels of minerals along with dietary fibre and bioactive compounds (Elleuch *et al.*, 2011) ^[7]. Their incorporation in the Chicken Meat Dip formulation significantly contributed to the improved calcium content, thereby enhancing the micronutrient density of the product. This approach aligns with current trends in functional food development, where plant-based fortification of animal products is employed to improve nutritional quality.

In comparison, plant-based dip products such as chickpea and broad bean dips exhibit variable mineral content depending on formulation. Makhloufi and Yamani (2024) ^[18] reported that legume-based dips possess appreciable mineral content, reflected by ash values ranging from 1.5–1.8%, while Jadayil *et al.* (2024) ^[12] highlighted the nutritional contribution of legumes, including minerals and B-vitamins, in chickpea and broad bean dips. However, although legumes contribute minerals, they are not particularly rich in calcium when compared to oilseeds such as sesame. Therefore, the inclusion of sesame seed powder in the present study offers a distinct advantage in terms of calcium enrichment.

From a nutritional standpoint, the developed Chicken Meat Dip provides approximately 15% of the recommended daily intake (RDI) of calcium, indicating that it can serve as a moderate source of dietary calcium. Adequate calcium intake is essential for bone mineralization, skeletal development, and prevention of osteoporosis, particularly in vulnerable groups such as children, adolescents, and the elderly population.

Vitamin A Content

The vitamin A content of the developed Chicken Meat Dip was recorded as 185 µg (as retinol equivalents), indicating a substantial enhancement in micronutrient density through formulation. The primary contributor to vitamin A in the

developed product is carrot purée, which is rich in β-carotene, a provitamin A carotenoid. β-carotene is converted into active vitamin A (retinol) in the human body and is widely recognized for its nutritional and functional significance.

The vitamin A content of chicken meat is influenced by several factors, including dietary supplementation, age of the bird, fat content and processing methods. Supplementation of poultry feed with vitamin A or carotenoids can increase deposition in tissues, particularly in the liver and skin. However, deposition in muscle tissue remains relatively low. According to Lawrie and Ledward (2014) ^[16], the vitamin A content in lean chicken muscle is negligible compared to organ meats, which may contain significantly higher concentrations. Therefore, the incorporation of carrot purée in the present formulation played a crucial role in enhancing the vitamin A content of the product.

Carrots are among the richest dietary sources of β-carotene, which exhibits strong antioxidant properties and serves as an important precursor of vitamin A. The inclusion of carrot purée in meat-based products has been reported to improve both nutritional value and functional properties, particularly by increasing antioxidant potential and contributing to improved colour and consumer appeal (Rodriguez-Amaya, 2001) ^[27]. The fat present in the formulation may further enhance the bioavailability of carotenoids, as carotenoids are fat-soluble compounds whose absorption is facilitated in the presence of dietary lipids.

The findings of the present study are in agreement with earlier reports on the nutritive enhancement of meat products through plant-based fortification. In the study titled “*Nutritive Profile of Canned Goat Meat Food with Added Carrot*”, the inclusion of carrot significantly increased the β-carotene and vitamin A content of the product, thereby improving its nutritional and functional value. The authors reported that carrot incorporation not only enhanced micronutrient density but also contributed to improved antioxidant properties and overall product acceptability.

From a nutritional standpoint, the enhanced vitamin A content contributes to several health benefits, including maintenance of normal vision, immune function, and epithelial integrity. Additionally, the antioxidant properties of β-carotene help in reducing oxidative stress, thereby contributing to overall health. The improved vitamin A content thus supports the development of the product as a functional food with added health benefits. In comparison, legume-based dips generally contain minimal vitamin A, unless specifically fortified with carotenoid-rich ingredients (Makhloufi & Yamani, 2024; Jadayil *et al.*, 2024) ^[18, 12]. Therefore, the incorporation of carrot purée provides a distinct nutritional advantage by enhancing the micronutrient profile of the developed Chicken Meat Dip.

Gross Energy Value

Gross energy increased from 1541 kcal (T₁) to 1771 kcal (T₂). The increase is directly related to higher fat content in T₂, as fat contributes 9 kcal/g. Legume dips derive more energy from carbohydrates, whereas the developed dip derives energy primarily from protein and fat.

Sensory quality of Fortified Chicken Meat Dip

The sensory attributes of the developed chicken meat dip formulations were evaluated using a hedonic scale, and the results are presented in Table 2. The evaluated parameters included appearance and colour, flavour, consistency, taste, and overall acceptability. The mean sensory scores indicated

that both formulations were well accepted by the panelists, with scores ranging from 7.38 to 7.65, suggesting that the products were “liked moderately” to “liked very much.”

Table 2: Sensory attributes of Fortified Chicken Meat Dip

Parameters	T ₁	T ₂
Appearance and Colour	7.40±0.16 ^a	7.65±0.01 ^b
Flavour	7.21±0.08 ^a	7.46±0.07 ^b
Consistency	7.38±0.14 ^a	7.56±0.11 ^b
Taste	7.38±0.14 ^a	7.56±0.11 ^b
Overall acceptability	7.47±0.11 ^a	7.58±0.14 ^b

T₁- without sesame seed powder and T₂- with sesame seed powder
Mean ± SE with same superscript within classes do not differ significantly ($p > 0.05$). n =6 for each treatment

Appearance and colour

Among the treatments, T₂ exhibited comparatively higher scores for all sensory attributes than T₁. The score for appearance and colour was significantly higher in T₂ (7.65±0.01) compared to T₁ (7.40±0.16). This improvement may be attributed to the higher fat content and better emulsification, which enhanced colour uniformity and visual appeal. The incorporation of carrot purée may have also contributed to desirable colour characteristics. Fat plays an important role in light reflectance and visual appeal in emulsion-type meat products (Toldrá, 2017) [31]. The incorporation of carrot purée also likely contributed to the attractive colour profile due to its high β -carotene content. Carotenoids impart a natural orange hue and improve product brightness and consumer appeal (Rodriguez-Amaya, 2001) [27]. Similar improvements in colour characteristics following carrot incorporation have been reported in hybrid meat products and meat emulsions (Mudalal *et al.*, 2025; Siti Susanti *et al.*, 2022) [19, 30]. Furthermore, Chomanov *et al.* (2022) [6] observed enhanced colour and acceptability in carrot-fortified canned goat meat products, supporting the present findings. Further, Mudalal *et al.* (2025) [19] reported that carrot pulp incorporation improved colour attributes and visual quality in hybrid meat products. Siti Susanti *et al.* (2022) [30] also demonstrated that carrot substitution significantly enhanced colour and sensory acceptability in rabbit meat nuggets. Additionally, studies on fibre incorporation, such as the addition of carrot pomace in chicken sausages, have shown improved colour characteristics and product appearance (Yadav 2018) [35]. Thus, the combined effect of fat and carrot incorporation contributed to the superior appearance of T₂.

Flavour

Flavour scores were also higher in T₂ (7.46±0.07) than in T₁ (7.21±0.08). The enhanced flavour in T₂ can be linked to its higher fat content, as fat serves as a carrier of flavour compounds and improves flavour perception. Additionally, the presence of sesame seed powder may have imparted a characteristic nutty flavour, contributing to overall sensory enhancement. The improved flavour in T₂ can be attributed to the higher fat content, as lipids act as carriers of flavour compounds and enhance flavour perception and retention (Brewer, 2012) [5]. In addition, sesame seed powder incorporated in the formulation may have imparted a characteristic nutty flavour, further enhancing the sensory profile. Kumari (2016) [15] reported improved flavour and acceptability in chicken meat cutlets incorporated with sesame seeds, attributing the enhancement to the aromatic compounds and natural oils present in sesame. Similarly,

Indumathi *et al.* (2020) [11] demonstrated that incorporation of ground sesame seed improved sensory characteristics and functional properties of chicken sausages. These findings support the positive influence of sesame inclusion on flavour development in the present study. Carrot incorporation has also been shown to positively influence flavour by imparting mild sweetness and improving flavour balance. Mudalal *et al.* (2025) [19] and Siti Susanti *et al.* (2022) [30] reported enhanced flavour scores in carrot-incorporated meat products, supporting the present findings.

Consistency

Consistency is a critical parameter for dip-type products, and T₂ recorded a higher score (7.56±0.11) compared to T₁ (7.38±0.14). The increased fat level in T₂ likely resulted in a smoother and more spreadable texture, which is desirable for dip formulations. Fat contributes to lubrication and emulsion stability, thereby improving the product's mouthfeel and cohesiveness. Fat plays a key role in stabilizing meat emulsions and improving product cohesiveness (Xiong, 2005) [34]. The presence of plant-based ingredients such as carrot and sesame seed may also contribute to water-binding and emulsion stability, thereby improving texture (Mudalal *et al.*, 2025; Yadav *et al.*, 2018) [19, 35]. Similarly, Indumathi *et al.* (2020) [11] reported improved functional properties and emulsion stability with sesame incorporation. These factors collectively contributed to the improved consistency observed in T₂.

Taste

Similarly, taste scores were higher in T₂ (7.56±0.11) than in T₁ (7.38±0.14), indicating better palatability. The improved taste in T₂ can be attributed to the combined effect of fat and flavour-enhancing ingredients, which enhance overall sensory perception. Increased fat levels are known to improve sensory perception and acceptability in meat products (Toldrá, 2017; Brewer, 2012) [31, 5]. Carrot incorporation may have also contributed to improved taste through natural sweetness and flavour balancing. Chomanov *et al.* (2022) [6] and Siti Susanti *et al.* (2022) [30] reported enhanced taste scores in carrot-fortified meat products. Additionally, sesame seeds contribute to flavour richness and mouthfeel, further enhancing taste perception (Kumari, 2016) [15].

Overall acceptability

Overall acceptability followed the same trend, with T₂ scoring higher (7.58±0.14) than T₁ (7.47±0.11). The higher overall acceptability of T₂ suggests that the formulation was more preferred by the sensory panel due to its superior flavour, texture, and mouthfeel. Fat content has been widely reported to positively influence sensory attributes such as juiciness, flavour intensity, and texture in emulsion-based meat products (Brewer, 2012) [5]. At the same time, incorporation of functional ingredients such as carrot and sesame enhances both sensory and nutritional quality. Kumari (2016) [15] reported improved overall acceptability in chicken meat cutlets incorporated with sesame seeds, while Indumathi *et al.* (2020) [11] observed enhanced sensory scores in sesame-incorporated chicken sausages. Similarly, Siti Susanti *et al.* (2022) [30] reported that carrot substitution significantly improved overall acceptability in rabbit meat nuggets, indicating the positive role of carrot in enhancing sensory attributes. Mudalal *et al.* (2025) [19] also reported improved acceptability in carrot-incorporated hybrid meat products. These findings support the present results, highlighting the

beneficial effects of plant-based fortification on sensory quality.

When compared with legume-based dips, which generally exhibit moderate sensory scores depending on formulation (Makhloufi & Yamani, 2024; Jadayil *et al.*, 2024) ^[18, 12], the developed chicken meat dip showed favourable sensory characteristics. The presence of animal protein and fat contributes to enhanced flavour richness, texture, and mouthfeel, providing an advantage over plant-based dip products. However, while T₂ showed superior sensory performance, T₁ had relatively lower fat content and higher moisture, which may be advantageous from a nutritional perspective. Therefore, the selection of formulation depends on the desired balance between sensory quality and nutritional considerations.

The sensory evaluation results indicate that both T₁ and T₂ formulations were organoleptically acceptable, with T₂ being the most preferred formulation. The superior sensory attributes of T₂ can be attributed to higher fat content, improved emulsion stability, and the synergistic effects of carrot purée and sesame seed powder. The inclusion of carrot improved colour, flavour, and overall acceptability, while sesame seeds enhanced flavour and texture. The findings are supported by studies on carrot-incorporated meat products, rabbit meat nuggets, and sesame-based chicken cutlets, confirming that the integration of plant-based functional ingredients can significantly enhance both sensory and nutritional quality of meat products.

Conclusion

The present study successfully developed a functional chicken meat dip enriched with carrot purée and sesame seed powder, demonstrating improved nutritional and sensory qualities. Carrot purée significantly enhanced vitamin A content, colour and antioxidant potential, while sesame seed powder increased calcium content, improved flavour and contributed to better textural properties.

The developed product exhibited high protein content along with moderate fat and added dietary fibre, indicating its potential as a nutritionally superior alternative to conventional meat products. The sesame-fortified formulation (T₂) showed better sensory acceptance, attributed to improved flavour, mouthfeel and emulsion stability. Based on the study results, incorporation of plant-based functional ingredients into meat products represents an effective strategy for developing nutrient-enriched, consumer-acceptable foods. The developed chicken meat dip has good potential for commercialization as a functional ready-to-eat product. Further studies on shelf-life, microbiological safety and process optimization are recommended.

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Conflict of Interest

Not available

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