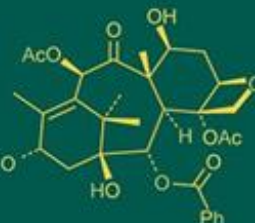
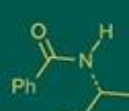
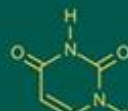
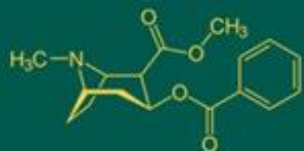


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N Bhanuprasad

Department of Livestock
Products Technology, CVSc,
Rajendranagar, PVNRTGVU,
Hyderabad, Telangana, India

M SahityaRani

Department of Livestock
Products Technology, CVSc,
Rajendranagar, PVNRTGVU,
Hyderabad, Telangana, India

M.SahityaRani

Department of Livestock
Products Technology, CVSc,
Rajendranagar, PVNRTGVU,
Hyderabad, Telangana, India

A Vijaya Kumar

Department of Veterinary
Public Health and
Epidemiology, CVSc,
Mamnoon, PVNRTGVU,
Hyderabad, Telangana, India

O Samrat

Department of Livestock
Products Technology, CVSc,
Rajendranagar, PVNRTGVU,
Hyderabad, Telangana, India

M Jahnavi

Department of Livestock
Products Technology, CVSc,
Rajendranagar, PVNRTGVU,
Hyderabad, Telangana, India

Corresponding Author:

N Bhanuprasad

Department of Livestock
Products Technology, CVSc,
Rajendranagar, PVNRTGVU,
Hyderabad, Telangana, India

Effect of lemongrass powder (*Cymbopogon Citratus*) as a binder replacer on quality and storage stability of chicken meat nuggets

N Bhanuprasad, M.SahityaRani, M Shashi Kumar, A Vijaya Kumar, O Samrat and M Jahnavi

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Abstract

The present study was conducted to evaluate the effect of lemongrass powder (*Cymbopogon citratus*) as a binder replacer on the quality characteristics and storage stability of chicken meat nuggets. Chicken nuggets were prepared by incorporating lemongrass powder at 0.6% (T1), 1.2% (T2), and 1.8% (T3) levels by replacing refined wheat flour, while nuggets without lemongrass powder served as the control. The products were evaluated for physico-chemical properties, sensory attributes, proximate composition, and storage stability under aerobic packaging at $4 \pm 1^\circ\text{C}$ for 25 days. Incorporation of lemongrass powder significantly ($P < 0.05$) decreased pH and increased cooking yield, while emulsion stability was not significantly affected. Sensory evaluation revealed that nuggets incorporated with 1.2% lemongrass powder had significantly ($P < 0.05$) higher scores for appearance, flavour, texture, juiciness, and overall acceptability. Proximate analysis showed a significant increase in moisture, protein, ash, and crude fibre content, while fat content decreased significantly with increasing levels of lemongrass powder. During refrigerated storage, pH, TBARS, and tyrosine values increased gradually, but nuggets containing lemongrass powder exhibited significantly ($P < 0.05$) lower values than the control, indicating improved oxidative and microbial stability due to the antioxidant properties of lemongrass. Overall, the study indicated that 1.2% lemongrass powder can be effectively used as a binder replacer to enhance the nutritional quality, sensory characteristics, and storage stability of chicken meat nuggets.

Keywords: *Cymbopogon citratus*, chicken nuggets, natural binder, lemongrass powder, tbars, tyrosine value

Introduction

Chicken meat is an important component of the human diet as it provides high-quality proteins, essential amino acids, vitamins and minerals necessary for good health (Feknous *et al.*, 2023) [1]. However, meat and meat products have a limited shelf life due to their highly perishable nature, mainly caused by oxidative degradation that leads to rancidity and quality deterioration (Awodoyin, 2025) [2]. To reduce oxidative deterioration and extend shelf life, both natural and synthetic antioxidants are used. In recent years, increasing consumer awareness about health and environmental concerns has promoted the use of natural bioactive compounds from plants. These compounds, such as polyphenols, flavonoids, terpenoids, and essential oils, help to reduce oxidative deterioration and improve the quality and safety of meat products (Olvera-Aguirre *et al.*, 2023) [3]. Chicken nuggets are emulsion-based processed meat products prepared from finely chopped or ground chicken meat. They are considered ready-to-eat products and are usually mixed with non-meat ingredients such as binders, fillers, spices, and functional additives to enhance flavour, texture, nutritional value, shelf stability, and overall consumer acceptability (Khatun *et al.*, 2022) [4].

The incorporation of plant-derived ingredients as binder replacer in processed foods has gained considerable attention due to their ability to improve functional properties, sensory characteristics and health benefits. One such ingredient is lemon grass powder (*Cymbopogon citratus*), gained recognition for its distinctive flavour and aroma, largely attributed to its rich flavonoid content, including luteolin, quercetin, and kaempferol. Lemon grass powder is abundant in bioactive compounds such as citral, myrcene, and polyphenols, which exhibit potent antioxidant and antimicrobial activities when added in meat products (Aly, 2021) [5]. Additionally, it provides multiple health-promoting effects, including anti-inflammatory, digestive, and anticancer properties, and has been reported to assist in managing chronic conditions such as hypertension

and diabetes (Manna *et al.*, 2024) [6]. Owing to these functional attributes, lemon grass powder can be used as a binder replacer for the development of healthier food products. The main objective of this research was to evaluate the effect of incorporation of lemon grass powder at various inclusion levels *i.e.*, 0.6%, 1.2% and 1.8%, as binder replacer on the quality and sensory attributes of chicken meat nuggets under aerobic packaging and stored at refrigeration temperature (4±1 °C), for a period of 25 days.

Materials and Methods

Broiler birds of market age were procured from the local market at Rajendranagar, Hyderabad. Slaughter and dressing were performed following standard procedures at the Department of Livestock Products Technology, College of Veterinary Science,

Rajendranagar. After post-mortem examination, the carcasses were chilled, drained, and deboned. Lean meat was separated from bones, packed in low-density polyethylene (LDPE) bags (200 gauge), and stored in a deep freezer at -18 °C until further use.

Frozen broiler meat was thawed under refrigeration (4±1 °C) and minced using a meat mincer (Sirman TC 32 Colorado, Italy) through 8 mm and subsequently 4 mm plates. Nuggets were prepared according to the formulation presented in Table 1, where lemongrass powder was incorporated at 0.6%, 1.2%, and 1.8% levels as a binder replacer. Meat emulsion was prepared using a bowl chopper (MADO Garrant MTK 661, Germany). Lemon grass powder was incorporated into chicken meat nuggets as a binder replacer at 0.6%, 1.2% and 1.8%.

Table 1: Formulation of Broiler chicken meat nuggets with incorporation of different levels of lemon grass powder

Ingredients		A. Treatments			
		Control	T1	T2	T3
Meat %		65.5	65.5	65.5	65.5
Fat %		10	10	10	10
Binder %	Refined Wheat Flour	6	5.4	4.8	4.2
	Lemon grass powder	-	0.6	1.2	1.8
Non meat ingredients					
Salt %		1.5	1.5	1.5	1.5
Sugar %		1	1	1	1
Polyphosphate (STPP)%		0.5	0.5	0.5	0.5
Ice flakes %		10	10	10	10
Dry Spice mix %		1.5	1.5	1.5	1.5
Kashmiri chilli powder %		0.5	0.5	0.5	0.5
Wet condiment mix %		3.5	3.5	3.5	3.5

Onion, ginger and garlic paste (2:1:1)

The prepared emulsion was filled into rectangular nugget boxes lined with aluminium foil, tightly packed, and cooked in boiling water at 80 °C for 40–45 min. After cooking, the boxes were cooled to room temperature and chilled overnight under refrigeration. The nuggets were then sliced and packaged in LDPE pouches (200 gauge) under aerobic conditions.

i) Emulsion parameters

The quality characteristics of broiler chicken meat emulsion were evaluated by measuring pH, emulsion stability, and cooking yield.

- **pH:** The pH of the meat emulsion was determined following the method described by Trout *et al.* (1992) [7].
- **Emulsion stability:** Emulsion stability was determined using the method of Townsend *et al.* (1968) [8] with slight modifications.

$$\text{Emulsion Stability (\%)} = \frac{\text{Final weight}}{\text{Initial weight}} \times 100$$

- **Cooking yield:** The percentage of cooking yield was determined by calculating the difference in weight of the nuggets before and after cooking, following the method described by Murphy *et al.* (1975) [9].

$$\text{Cooking Yield (\%)} = \frac{\text{Weight of nuggets after cooking}}{\text{Weight of raw nuggets}} \times 100$$

- ii) **Proximate composition:** The cooked nuggets were homogenized using a Waring blender prior to sampling. Moisture, fat, protein, and ash contents of the nuggets incorporating lemon grass powder were analyzed following the procedures recommended by the Association of Official Analytical Chemists (A.O.A.C., 2012) [10].

iii) Physico-chemical properties

p^H - pH was measured using digital pH meter as per the procedure described.

Thiobarbituric Acid Reacting Substances (TBARS) value - The distillation method outlined by Tarladgis *et al.* (1960) [11] was followed for the determination of TBARS value.

Tyrosine value (mg/100g) - Tyrosine value was estimated adopting the procedure of Strange *et al.* (1977) [12].

Statistical analysis - Data obtained in the present study were analyzed using SPSS version 24.0. The parameters were subjected to analysis of variance (ANOVA) and mean comparisons were performed using Duncan's New Multiple Range Test (Snedecor and Cochran, 1994) [13]. Oneway ANOVA was used for different levels of lemongrass powder, while two-way univariate ANOVA was applied for treatments and storage periods.

Results and Discussion

Multiple trials were conducted to develop chicken nuggets from broiler meat by incorporating various levels of lemon grass powder (0.6%, 1.2%, and 1.8%) was used as binder replacer, to develop chicken meat nuggets for further investigation. Lemon grass powder incorporated in various treatments of chicken meat nuggets as a binder replacer showed an antioxidant

activity of 462.50 µg/100g which is attributed to the presence of phenolic compounds such as *chlorogenic acid*, *caffeic acid* and other polyphenols, which were capable of donating hydrogen atoms or electrons to neutralize free radicals and terminate oxidative chain reactions, resulted in a strong antioxidant activity (Kusmardiyani *et al.*, 2016) ^[14].

Emulsion parameters

Emulsion properties of lemongrass powder incorporated broiler chicken meat emulsion and product are presented in Table 2.

The pH values of the emulsion showed a significant ($P < 0.05$) decrease with increasing levels of lemongrass powder. Among the treatments, nuggets incorporated with 1.8% lemongrass powder exhibited significantly ($P < 0.05$) lower pH than the control and other treatments.

The reduction in pH may be attributed to the presence of natural acidic compounds such as citral in lemongrass powder. Similar results were reported by Zaki (2022) ^[15] in chicken burgers with lemongrass extract and Lee *et al.* (2014) ^[16] in hamburger

patties incorporated with lemon balm powder. The incorporation of lemongrass powder (0.6%, 1.2%, and 1.8%) had no significant ($P > 0.05$) effect on emulsion stability, although a numerical increase was observed with higher inclusion levels. This may be due to the insoluble dietary fibre in lemongrass powder, which absorbs water and helps retain moisture and fat within the meat protein matrix, thereby improving emulsion stability. Similar findings were reported by Sutha *et al.* (2021) ^[17] in chicken nuggets treated with lemongrass oil.

Cooking yield of nuggets increased significantly ($P < 0.05$) with the incorporation of lemongrass powder, with the highest yield observed in T3 (1.8% LGP). The higher cooking yield may be attributed to the water-holding capacity of dietary fibre in lemongrass powder, which retains moisture and fat, reduces cooking losses, and improves product yield (Zhang *et al.*, 2023) ^[18]. Comparable results were reported by Sukmawardani *et al.* (2025) ^[19] in spent hen patties and Kumar (2016) ^[20] in chevon nuggets and balls incorporated with lemongrass.

Table 2: Effect of incorporation of different levels of lemon grass powder on physico- chemical properties of chicken meat emulsion and nuggets (Mean + SE)

Parameter	Control	Treatment		
		0.6%lemon grass powder	1.2%lemon grass powder	1.8%lemon grass powder
Emulsion pH	6.07 ± 0.06 ^a	5.95 ± 0.04 ^{ab}	5.83 ± 0.04 ^b	5.64 ± 0.03 ^c
Product pH	6.12 ± 0.05 ^a	5.99 ± 0.04 ^b	5.87 ± 0.04 ^c	5.69 ± 0.03 ^d
Emulsion stability (%)	83.31 ± 3.51	83.43 ± 3.44	83.51 ± 3.40	83.73 ± 3.28
Cooking yield (%)	86.25 ± 0.05 ^c	87.68 ± 0.05 ^b	89.18 ± 0.02 ^{ab}	91.12 ± 0.07 ^a

Means with different superscripts in the same row differed significantly ($P < 0.05$)

Sensory quality of chicken meat nuggets

The inclusion of lemon grass powder at different levels (0.6%, 1.2%, and 1.8%) caused significant ($P < 0.05$) difference in the sensory scores (Table -3) of all quality attributes of chicken meat nuggets.

The inclusion of lemongrass powder at different levels (0.6%, 1.2%, and 1.8%) significantly ($P < 0.05$) affected the sensory attributes of chicken meat nuggets. Nuggets incorporated with 1.2% lemongrass powder (T2) showed significantly ($P < 0.05$) higher appearance scores than the control, possibly due to antioxidant and colour-stabilizing compounds such as citral, flavonoids, and phenolic acids that inhibit lipid and myoglobin oxidation (Zaki, 2022) ^[15]. However, a higher inclusion level (1.8%) significantly ($P < 0.05$) reduced appearance scores because of the deep greenish-yellow colour and visible plant particles affecting colour uniformity (Awad, 2019) ^[21]. Similar improvements in colour were reported by Zaki (2022) ^[15], Boeira *et al.* (2020) ^[22] and Zaki *et al.* (2018) ^[23] in meat products treated with lemongrass extracts or oil.

Chicken nuggets incorporated with lemongrass powder up to 1.2% also exhibited significantly ($P < 0.05$) higher flavour scores than the control. This improvement may be attributed to aromatic bioactive compounds such as citral and terpenoids that impart a pleasant citrus flavour while reducing lipid oxidation and rancid off-flavours. However, higher inclusion (1.8%)

produced an intense herbal flavour that masked the natural meat flavour and reduced acceptability. Similar findings were reported by Lee *et al.* (2014) ^[16] and Boeira *et al.* (2020) ^[22].

Texture scores were significantly ($P < 0.05$) higher in nuggets incorporated with 1.2% lemongrass powder, possibly due to the interaction of dietary fibres with myofibrillar proteins, strengthening the protein–fibre matrix and improving structural integrity (Awodoyin, 2025) ^[2]. In contrast, the 1.8% level reduced texture scores due to excessive fibre interfering with protein gel formation. Similar observations were reported by Sukmawardani *et al.* (2025) ^[19] and Boeira *et al.* (2020) ^[22].

Juiciness scores were also significantly ($P < 0.05$) higher in nuggets containing 1.2% lemongrass powder, likely due to the high insoluble fibre content that enhances water-binding capacity and moisture retention during cooking. However, at 1.8% inclusion, excess fibre tightly bound water, reducing moisture release during chewing and lowering juiciness scores. Comparable results were reported by Awad (2019) ^[21] and Lee *et al.* (2014) ^[16].

Overall, the improved appearance, flavour, texture, and juiciness resulted in significantly ($P < 0.05$) higher overall acceptability for nuggets incorporated with 1.2% lemongrass powder compared to the control and other treatments. Similar findings were reported by Lee *et al.* (2014) ^[16], Awodoyin (2025) ^[2] and Boeira *et al.* (2020) ^[22].

Table 3: Effect of incorporation of different levels of lemon grass powder on (Mean±SE) values of organoleptic qualities of chicken meat nuggets

Parameter	Control	Treatment		
		0.6%lemon grass powder	1.2%lemon grass powder	1.8%lemon grass powder
Appearance	7.41 ± 0.03 ^b	7.50 ± 0.02 ^b	7.82 ± 0.04 ^a	6.32 ± 0.06 ^c
Flavour	7.32 ± 0.01 ^c	7.66 ± 0.02 ^b	8.07 ± 0.01 ^a	5.85 ± 0.07 ^d
Texture	7.47 ± 0.05 ^c	7.69 ± 0.04 ^b	7.86 ± 0.03 ^a	6.91 ± 0.04 ^d
Juiciness	7.15 ± 0.05 ^c	7.31 ± 0.05 ^b	7.58 ± 0.04 ^a	6.42 ± 0.03 ^d
Overall acceptability	7.58 ± 0.01 ^c	7.84 ± 0.02 ^b	8.10 ± 0.04 ^a	7.09 ± 0.03 ^d

Means with different superscripts in the same row differed significantly ($P<0.05$)

Proximate composition of lemon grass powder incorporated in chicken meat nuggets

Table 4 presents the proximate composition of chicken meat nuggets incorporated with lemongrass powder (LGP), including moisture, crude protein, crude fat, total ash, and crude fibre content.

The moisture content of nuggets showed a non-significant ($P>0.05$) increase from control to T2, followed by a comparable decrease in T3. The highest moisture was observed in T2, which may be attributed to the higher dietary fibre and water-holding capacity of lemongrass powder. The cellulose and hemicellulose fibres in LGP bind water through hydrogen bonding, enhancing moisture retention. However, the higher inclusion level (1.8%) introduced more solids into the matrix, resulting in comparatively lower moisture than T2. Similar observations were reported by Allam *et al.* (2024) [24] in meat patties incorporated with lemon verbena leaf extract.

The protein content increased significantly ($P<0.05$) with higher levels of lemongrass powder. This increase may be due to the relatively higher protein content of lemongrass powder (about 8.2%) compared to refined wheat flour used as a binder (Manna *et al.*, 2024) [6]. Similar increases in protein content were reported by Awodoyin (2025) [2] in chicken meat balls and

Hussein *et al.* (2015) [25] in beef burgers incorporated with lemongrass.

The crude fat content decreased significantly ($P<0.05$), with the lowest value observed in nuggets containing 1.8% LGP. This reduction may be attributed to the low-fat content of lemongrass powder (approximately 3.1%) and its high dietary fibre, which dilutes the fat fraction in the product. Comparable results were reported by Abd El-Wahab (2018) [26] in beef burgers incorporated with lemongrass powder.

The ash content increased significantly ($P<0.05$) with increasing levels of LGP, with the highest value in T3 and the lowest in the control. This increase may be due to the higher mineral content of lemongrass powder (Karaituma *et al.*, 2025) [27]. Similar findings were reported by Awodoyin (2025) [2], Abd El-Wahab (2018) [26], Hussein *et al.* (2015) [25] and Boeira *et al.* (2020) [22] in meat products incorporated with lemongrass.

The crude fibre content increased significantly ($P<0.05$) with increasing levels of lemongrass powder. As LGP is rich in fibre components such as cellulose, hemicellulose, and pectin, its incorporation enhanced the crude fibre content of the nuggets (Karaituma *et al.* 2025) [27]. Similar increases in crude fibre were reported by Awodoyin (2025) [2], Abd El-Wahab (2018) [26] and Hussein *et al.* (2015) [25] in meat products incorporated with lemongrass.

Table 4: Effect of incorporation of different levels of lemon grass powder on (Mean±SE) values of proximate composition of chicken meat nuggets

Parameter	Control	Treatment		
		0.6%lemon grass powder	1.2%lemon grass powder	1.8%lemon grass powder
Moisture (%)	62.47 ± 0.11 ^a	63.09 ± 0.10 ^a	63.42 ± 0.10 ^a	62.70 ± 0.09 ^{ab}
Crude protein (%)	18.50 ± 0.01 ^c	19.11 ± 0.01 ^b	19.46 ± 0.40 ^b	20.26 ± 0.47 ^a
Ether extract (%)	14.31 ± 0.12 ^a	13.07 ± 0.16 ^b	11.58 ± 0.14 ^c	9.95 ± 0.08 ^d
Total ash (%)	2.17 ± 0.08 ^c	2.89 ± 0.10 ^{bc}	3.27 ± 0.09 ^b	3.93 ± 0.11 ^a
Crude fibre (%)	1.65 ± 0.14 ^d	1.84 ± 0.22 ^c	2.27 ± 0.19 ^b	3.16 ± 0.16 ^a

Means with different superscripts in the same row differed significantly ($P<0.05$)

Effect of storage (4±1 °C) on the physico-chemical, properties of chicken meat nuggets ° packaged in aerobic conditions

Effect of lemon grass powder incorporation on pH, TBARS and Tyrosine Value (TV) of chicken meat nuggets during refrigerated storage at 4±1 °C were analysed.

pH

The pH of aerobically packaged chicken meat nuggets increased significantly ($P<0.05$) during the refrigerated storage period (Table 5). However, nuggets incorporated with lemongrass powder (T1, T2, and T3) showed a significantly ($P<0.05$) lower increase in pH compared to the control. The rise in pH may be attributed to microbial and enzymatic breakdown of proteins, resulting in the formation of alkaline compounds such as ammonia, dimethylamine, and trimethylamine (Zaki, 2022) [15]. Similar trends were reported by Oyesanwen *et al.*

(2017) [28] in chevon patties with *Cymbopogon citratus* extract, Bakheet *et al.* (2024) [29] in beef burgers formulated with lemongrass oil nano emulsion, and Morshdy *et al.* (2021) [30] in rabbit meat treated with lemongrass oil, where pH increased during storage but remained lower than the control.

TBARS value (mg malondialdehyde/Kg)

Thiobarbituric Acid Reactive Substances (TBARS) values (Table 6) showed that chicken meat nuggets incorporated with 0.6%, 1.2%, and 1.8% lemongrass powder had significantly ($P<0.05$) lower TBARS values than the control throughout refrigerated storage (4±1 °C). TBARS values increased significantly ($P<0.05$) in both control and treated samples from day 0 to day 25 under aerobic packaging conditions. However, nuggets containing lemongrass powder consistently exhibited lower TBARS values due to the strong antioxidant activity of

phenolic compounds such as *caffeic acid*, *p-coumaric acid*, and *ferulic acid*, which neutralize free radicals and inhibit lipid oxidation (Kieling *et al.*, 2021) [31]. Similar results were reported by Eldeeb and Mosilhey (2018) [32] in chicken burgers with lemongrass leaves and Zaki *et al.* (2018) [23] in camburger incorporated with lemongrass oil, where TBARS values were lower than the control.

Tyrosine value (mg/100g)

The mean $\pm$ SE tyrosine values (mg/100 g) of control and chicken meat nuggets incorporated with 0.6%, 1.2%, and 1.8% lemongrass powder, stored under refrigeration (4 ± 1 °C), are presented in Table 7. Tyrosine values increased significantly

($P<0.05$) in all treatments as storage progressed from day 0 to day 25. However, nuggets containing lemongrass powder (T1, T2, and T3) showed significantly ($P<0.05$) lower tyrosine values than the control under aerobic packaging. This reduction may be attributed to the antioxidant and antimicrobial properties of bioactive compounds in lemongrass, which inhibit proteolytic spoilage microorganisms and protect muscle proteins from oxidative degradation, thereby slowing protein breakdown and limiting the release of free tyrosine. Similar findings were reported by Sutha *et al.* (2024) [33] in chicken meat nuggets incorporated with thyme oil, which also showed lower tyrosine values than the control.

Table 5: Effect of incorporation of lemon grass powder on (Mean $\pm$ SE) pH values of aerobically packaged chicken meat nuggets stored under refrigerated temperature (4 ± 1 C) °

Treatments	Storage days					
	0 th day	5 th day	10 th day	15 th day	20 th day	25 th day
Control	6.12 $\pm$ 0.05 ^{aE}	6.17 $\pm$ 0.09 ^{aE}	6.32 $\pm$ 0.08 ^{aD}	6.48 $\pm$ 0.05 ^{aC}	6.83 $\pm$ 0.09 ^{aB}	7.20 $\pm$ 0.05 ^{aA}
0.6% lemon grass powder	5.99 $\pm$ 0.04 ^{bE}	6.03 $\pm$ 0.10 ^{bE}	6.14 $\pm$ 0.09 ^{bD}	6.27 $\pm$ 0.08 ^{bC}	6.41 $\pm$ 0.08 ^{bB}	6.58 $\pm$ 0.01 ^{bA}
1.2% lemon grass powder	5.87 $\pm$ 0.04 ^{cE}	5.91 $\pm$ 0.06 ^{cDE}	6.00 $\pm$ 0.08 ^{cD}	6.11 $\pm$ 0.06 ^{cC}	6.24 $\pm$ 0.09 ^{cB}	6.40 $\pm$ 0.11 ^{cA}
1.8% lemon grass powder	5.69 $\pm$ 0.03 ^{dE}	5.73 $\pm$ 0.07 ^{dDE}	5.81 $\pm$ 0.01 ^{dCD}	5.90 $\pm$ 0.08 ^{dC}	6.00 $\pm$ 0.07 ^{dB}	6.14 $\pm$ 0.04 ^{dA}

Means with different superscripts in the same row (upper case letters) and column (lower case letters) differed significantly ($P<0.05$)

Table 6: Effect of incorporation of lemon grass powder on (Mean $\pm$ SE) values of TBARS (mg malondialdehyde/kg) of aerobically packaged chicken meat nuggets stored under refrigerated temperature (4 ± 1 C) °

Treatments	Storage days					
	0 th day	5 th day	10 th day	15 th day	20 th day	25 th day
Control	0.46 $\pm$ 0.03 ^{aD}	0.57 $\pm$ 0.05 ^{aD}	0.69 $\pm$ 0.03 ^{aCD}	0.90 $\pm$ 0.04 ^{aC}	1.29 $\pm$ 0.04 ^{aB}	1.80 $\pm$ 0.09 ^{aA}
0.6% lemon grass powder	0.40 $\pm$ 0.04 ^{abE}	0.47 $\pm$ 0.06 ^{abDE}	0.56 $\pm$ 0.04 ^{bCD}	0.66 $\pm$ 0.03 ^{bC}	0.81 $\pm$ 0.04 ^{bB}	1.26 $\pm$ 0.04 ^{bA}
1.2% lemon grass powder	0.36 $\pm$ 0.02 ^{abE}	0.41 $\pm$ 0.03 ^{bcDE}	0.48 $\pm$ 0.04 ^{bcCD}	0.57 $\pm$ 0.04 ^{bcC}	0.71 $\pm$ 0.02 ^{bcB}	0.94 $\pm$ 0.03 ^{cA}
1.8% lemon grass powder	0.31 $\pm$ 0.03 ^{bE}	0.36 $\pm$ 0.09 ^{cDE}	0.43 $\pm$ 0.06 ^{cD}	0.51 $\pm$ 0.09 ^{cC}	0.63 $\pm$ 0.03 ^{cB}	0.82 $\pm$ 0.03 ^{cA}

Means with different superscripts in the same row (upper case letters) and column (lower case letters) differed significantly ($P<0.05$)

Table 7: Effect of incorporation of lemon grass powder on (Mean $\pm$ SE) values of Tyrosine(mg/100g) of aerobically packaged chicken meat nuggets stored under refrigerated temperature (4 ± 1 C) °

Treatments	Storage days					
	0 th day	5 th day	10 th day	15 th day	20 th day	25 th day
Control	3.12 $\pm$ 0.04 ^{aF}	4.61 $\pm$ 0.03 ^{aE}	7.40 $\pm$ 0.04 ^{aD}	10.77 $\pm$ 0.04 ^{aC}	15.85 $\pm$ 0.04 ^{aB}	22.35 $\pm$ 0.05 ^{aA}
0.6% lemon grass powder	2.74 $\pm$ 0.05 ^{bF}	4.04 $\pm$ 0.06 ^{bE}	6.46 $\pm$ 0.01 ^{bD}	9.45 $\pm$ 0.05 ^{bC}	12.47 $\pm$ 0.05 ^{bB}	15.58 $\pm$ 0.06 ^{bA}
1.2% lemon grass powder	2.25 $\pm$ 0.05 ^{cF}	3.39 $\pm$ 0.04 ^{cE}	5.40 $\pm$ 0.03 ^{bD}	7.63 $\pm$ 0.04 ^{cC}	10.01 $\pm$ 0.05 ^{cB}	12.51 $\pm$ 0.04 ^{cA}
1.8% lemon grass powder	1.19 $\pm$ 0.04 ^{dF}	2.12 $\pm$ 0.03 ^{dE}	3.42 $\pm$ 0.04 ^{cD}	5.18 $\pm$ 0.03 ^{dC}	7.25 $\pm$ 0.06 ^{dB}	9.91 $\pm$ 0.04 ^{dA}

Means with different superscripts in the same row (upper case letters) and column (lower case letters) differed significantly ($P<0.05$)

Conclusion

Incorporation of lemongrass powder as a binder replacer improved the quality, nutritional composition, and storage stability of chicken meat nuggets. Nuggets containing 1.2% lemongrass powder showed the best sensory acceptability, while higher levels enhanced cooking yield and nutritional value. Additionally, lemongrass powder reduced the increase in pH, TBARS, and Tyrosine values than the control during the refrigerated storage, indicating improved oxidative and microbial stability. Hence, 1.2% lemongrass powder can be recommended for the development of improved chicken meat nuggets.

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