

Effect of different fat levels and *Moringa oleifera* leaf meal inclusion on sensory attributes of chicken droëwors

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Abstract

Moringa oleifera Lam. is an innovative nutraceutical and nutritional plant for animal and human diets. The plant has potent essential nutrients such as vitamins and minerals, protein, and essential amino acids, with a relatively small quantity of antinutrients. Hence the increase of its use in medicinal remedies and traditional cuisines in many parts of the globe. This study aimed to investigate the effects of different fat levels and *Moringa oleifera* leaf meal (MOLM) inclusion on sensory attributes of chicken droëwors. A total of forty randomly selected consumers of different gender and age were used as the sensory panel. About 75% of lean chicken meat and 25% of chicken fat were used during droëwors preparation. The raw materials were divided into nine (9) treatments i.e., T1 (0% fat, 0% MOLM), T2 (0% fat, 0.25% MOLM), T3 (0% fat, 0.5% MOLM), T4 (10% fat, 0% MOLM), T5 (10% fat, 0.25% MOLM) T6 (10%, 0.5% MOLM), T7 (15% fat, 0% MOLM), T8 (15% fat, 0.25% MOLM) and T9 (15% fat, 0.5% MOLM). In terms of colour, when 0.5% MOLM was added consumers responded with low values, 6.74 and 6.14 in T3 and T9, respectively, compared to other treatments. The aroma scores in treatments that added no MOLM were significantly lower ($P < 0.05$) than in other treatments with MOLM added, however, no significant difference was found in other treatments. Regarding texture, the consumer's panel in the current study responded with lower values (T3 = 6.35, T6 = 6.74, T9 = 5.81 when 0.5% MOLM was added. Meat flavour was significantly increased ($P > 0.05$), where 0.25% MOLM was added. Overall preference score in chicken droëwors significantly increased ($P > 0.05$) by adding 0.5% of MOLM in all the treatments; consumers liked chicken droëwors when 0.5% of MOLM was added. Droëwors with MOLM had higher ($P > 0.05$). The inclusion of *Moringa oleifera* leaf meal in chicken droëwors significantly improved its sensory attributes.

1. Introduction

Droëwors are ready-to-eat dried salted sausages, commonly made using beef and game meat globally, and they are regarded as a snack by some consumers (Mukumbo *et al.*, 2018). However, nowadays, they can also be made using chicken meat. Chicken meat is one of the most significant protein sources worldwide and is mainly demanded by consumers because of its low production cost and outstanding nutritional quality (Candan and Aytunga, 2017). The current study focuses on making droëwors using chicken meat rather than other meat types because it is accepted worldwide since it is not expensive and has excellent nutritional value (Konieczka *et al.*, 2017). Even though chicken meat is

known to have positive dietary attributes, it is also known to have high polyunsaturated fatty acids, making it difficult for it to be used in making droëwors because of the exposure to oxidation processing (Cortinas *et al.*, 2005). Food additives are often included in the processing of meat products to enhance the shelf-life and improve the product's sensory attributes (Hoffman *et al.*, 2014). Therefore, the present study focuses on the use of antioxidants to hinder the process of oxidation. Antioxidants are divided into natural and synthetic antioxidants (Wilson *et al.*, 2017). However, synthetic antioxidants are known to have carcinogenic effects.

Many authors recommend natural antioxidants rather than synthetic antioxidants due to their medicinal and

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nutritional value (Atta *et al.*, 2017). Consumers are aware of natural plant additives in food products as they are concerned about their health (Farooq *et al.*, 2012). Natural antioxidants are known to have vitamin C, phenolic compounds, and flavonoids. Therefore, *Moringa oleifera* is a natural antioxidant that can delay oxidation during meat product processing (Pakade *et al.*, 2013). Lipid oxidation poses a primary challenge in the meat industry. This is all because consumers these days have progressively valued suitable products that are ready-to-eat such as droëwors. Hence the current study considered using *Moringa oleifera* to improve and keep the sensory attributes of chicken droëwors, promoting consumers' acceptability (Amaral *et al.*, 2018).

2. Materials and methods

2.1 Ethical clearance

Ethical clearance was obtained from the University of Fort Hare Research Ethics Committee before commencing droëwors production and sensory evaluation (Ethical clearance number: MUC561STEM01).

2.2 Production of chicken droëwors

Lean chicken meat and chicken fat were purchased from Tremeers butchery in Alice, South Africa. Lean chicken meat, chicken fat, and dehydrated natural sheep casings (Usually stored in salt and rehydrated in water before it is used) (22 mm diameter, Freddy Hirsch) were prepared. Salt and ground peppers were purchased for droëwors preparation. The lean meat and fat were trimmed into 5×5 cm cubes and were divided into nine (9) batches and nine (9) treatments. The treatments were prepared with different combinations of fat and MOLM (Table 1).

Table 1. The treatments were prepared with different combinations of fat and MOLM

Treatments	Amount of fat (%)	Amount of MOLM (%)
T1	0 % fat	0 % MOLM
T2	0 % fat	0.25 % MOLM
T3	0 % fat	0.5 % MOLM
T4	10 % fat	0 % MOLM
T5	10 % fat	0.25 % MOLM
T6	10 % fat	0.5 % MOLM
T7	15 % fat	0 % MOLM
T8	15 % fat	0.25 % MOLM
T9	15 % fat	0.5 % MOLM

Thereafter, the chicken droëwors were prepared. Each batch was minced through a 5 mm grinder. Each batch of mince was weighed, salt (2%) and pepper (0.5%) were thoroughly incorporated into the mixture. Thereafter, the MOLM was added to each batch according to the treatment levels described. The batches

were minced separately through a 2 mm screen into natural sheep casings (22 diameters, Freddy Hirsch) and were hung vertically in a drying chamber at 30° C and 40% relative humidity, and this was done for 72 hrs. The droëwors were hanged according to treatments (T1-T9) on each tier in the drier to prevent mixing of the treatments, and the weights of each batch were recorded before and after the drying process to monitor the weight loss.

2.3 Sensory evaluation

Droëwors were analysed by a trained consumer panel (n = 40). A descriptive sensory evaluation method was used. The panellists were randomly selected but of different gender (males and females). They were trained using the general explanatory analysis procedure two weeks before the trial session (Hoffman *et al.*, 2014). Panellists were addressed on evaluating and scoring the samples, and an instruction information sheet was provided. A random nine (9) digit code were assigned to each treatment and were presented to the panellists in random order. Each panellist was given a 3 cm long piece of droëwors from each treatment. The waiting period between each sample was 10 mins. Plain crackers and water were provided to cleanse the palate after each sample to avoid crossover effects. Each panellist was completing and evaluating the form rating the characteristics of each sample on a nine-point scale for attributes pertaining to its colour (1 = extremely light pink to 9 = extremely dark brown), aroma (1 = extremely bland to 9 = extremely intense), saltiness (1 = extremely non salty to 9 = extremely salty), texture (1 = extremely soft to 9 = extremely hard), meat flavour (1 = extremely bland to 9 = extremely intense), spicy flavour (1 = extremely bland to 9 = extremely intense and overall preference (1 = dislike extremely to 9 = like extremely). Off flavour indicators were bitter, grassy, and metallic.

2.4 Data analysis

The entire experiment was performed at different times in the same place, and a completely randomized design was used. The data in the sensory attributes (aroma, colour, texture, saltiness, meat flavour, and spicy flavour) of chicken droëwors were analysed by an analysis of variance (one-way ANOVA) using the GLM procedure of SAS program. Duncan's multiple range test was used to determine the statistical significance among the means at a 95% significance level. Mean values were reported. All data analysis was performed using SAS, 2003.

The statistical model used is as follows:

$$Y_{ijkl} = \mu + \alpha_i + \beta_j + c_k + \alpha\beta_{ijk} + e_{ijkl}$$

Where Y_{ijkl} = dependent variable (sensory evaluation), μ = overall mean, α_i = the effect of fat (10%, 15%), β_j = effect of *Moringa oleifera* leaf meal (0 %, 0.25% MOLM and 0.5% MOLM), c_k = effect of treatment (T₁(0% fat, 0% MOLM), T₂(0% fat, 0.25% MOLM), T₃(0% fat, 0.5% MOLM), T₄(10% fat, 0% MOLM), T₅(10% fat, 0.25% MOLM) T₆(10%, 0.5% MOLM), T₇(15% fat, 0% MOLM), T₈(15% fat, 0.25% MOLM), T₉(15% fat, 0.5% MOLM), $\alpha\beta\gamma_{ijk}$ = interaction (between fat and MOLM at different levels of inclusion) and e_{ijkl} = random error.

3. Results

3.1 Perception of consumers on chicken droëwors in terms of sensory parameters

The sensory evaluation of chicken droëwors samples treated with *Moringa oleifera* leaf meal (MOLM) is shown in Table 2. For colour, consumers responded with low values, 6.74 and 6.14 in treatment group T3 and T9, respectively, when 0.5% MOLM was added, compared to other treatments. The aroma scores in treatments that added no MOLM were significantly lower ($P < 0.05$)

than in other treatments with MOLM added, however, no significant difference was found in other treatments. Regarding texture, the consumer's panel in the current study responded with lower values (T3 = 6.35, T6 = 6.74, T9 = 5.81) when 0.5% MOLM was added. Meat flavour was significantly increased ($P > 0.05$), where 0.25% MOLM was added. Meat flavour was significantly increased ($P > 0.05$), where 0.25% of MOLM was added. Overall preference score in chicken droëwors significantly increased ($P > 0.05$) by the addition of 0.5% of MOLM. It can be concluded that consumers liked chicken droëwors when 0.5% of MOLM was added. Droëwors with MOLM had higher ($P > 0.05$) colour scores in T2 and control.

The effect of *Moringa oleifera* leaf meal (MOLM) and fat on consumer sensory attributes in terms of consumer perception is shown in Table 3. Consumers gave higher ($P < 0.05$) scores (7.79) on chicken droëwors overall preference. *Moringa oleifera* leaf meal (MOLM) had a positive influence ($P < 0.05$) on chicken droëwors characteristics.

Table 2. Effect of graded level of *Moringa oleifera* leaf meal (MOLM) and fat on consumer sensory evaluation of chicken droëwors

Treatments	Treatment description	Sensory Parameters						Overall Preference
		Colour	Aroma	Meat Flavour	Saltiness	Spicy Flavour	Texture	
T1	Control 1 (0% Fat)	6.91 ^{bB}	6.82 ^{Bbc}	6.51 ^{ab}	5.24 ^{bc}	6.93 ^{cA}	6.76 ^{ab}	6.15 ^b
T2	0.25M, 0% Fat	7.13 ^{aB}	7.43 ^a	7.15 ^{bAB}	6.88 ^{bBC}	6.32 ^{bcC}	7.13 ^a	7.15 ^a
T3	0.5M, 0% Fat	6.74 ^{bcBC}	7.26 ^b	6.5 ^{abA}	4.89 ^c	6.24 ^{bAB}	6.35 ^{ab}	7.38 ^a
T4	Control 2 (5% Fat)	6.54 ^{ab}	6.65 ^b	5.73 ^{bAB}	6.35 ^{AB}	7.41 ^a	7.77 ^a	5.51 ^{CB}
T5	0.25M, 5% Fat	7.13 ^a	7.65 ^{aA}	7.22 ^{aAB}	7.15 ^{aB}	7.24 ^a	7.13 ^a	7.05 ^{bcB}
T6	0.5M, 5% Fat	6.84 ^{aB}	7.15 ^a	7.16 ^a	7.14 ^a	6.88 ^{ab}	6.74 ^B	7.14 ^{ab}
T7	Control 3 (10% Fat)	6.94 ^{bB}	6.73 ^b	6.15 ^a	6.16 ^{cA}	6.13 ^{bB}	6.58 ^{ab}	5.91 ^b
T8	0.25M, 10% Fat	7.13 ^a	7.14 ^a	7.16 ^{bAB}	6.91 ^a	6.83 ^{ab}	7.44 ^a	5.83 ^b
T9	0.5M,10% Fat	6.14 ^a	7.11 ^{aB}	6.77 ^b	6.51 ^b	6.35 ^b	5.81 ^b	7.15 ^{aB}

Values are presented as means. Values with different lowercase superscript within the same column are significantly different ($P < 0.05$) while values with different uppercase superscript within the same row are significantly different ($P < 0.05$).

Table 3. Consumer perception of chicken droëwors in terms of sensory parameters.

Treatments	Treatment description	Sensory Parameters						Overall Preference
		Colour	Aroma	Meat Flavour	Saltiness	Spicy Flavour	Texture	
T1	Control 1 (0% Fat)	7.51 ^{abAB}	7.75 ^a	6.94 ^{bB}	7.56 ^a	6.34 ^{bcC}	6.29 ^{cB}	7.79 ^a
T2	0.25M, 0% Fat	7.08 ^B	7.36 ^a	6.11 ^b	7.00 ^B	6.32 ^{bcC}	6.41 ^a	5.15 ^b
T3	0.5M, 0% Fat	6.89 ^{AB}	6.55 ^a	6.39 ^{AB}	6.55 ^{cAB}	6.39 ^{AB}	7.35 ^{ab}	6.38 ^{AB}
T4	Control 2 (5% Fat)	7.57 ^a	7.33 ^a	6.01 ^{bc}	6.11 ^{ab}	7.24 ^a	7.54 ^a	6.81 ^{AB}
T5	0.25M, 5% Fat	6.59 ^b	7.41 ^a	5.54 ^c	5.90 ^b	5.87 ^b	6.55 ^b	6.59 ^B
T6	0.5M, 5% Fat	5.48 ^c	6.57 ^b	6.51 ^{ab}	6.37 ^b	6.11 ^b	5.60 ^c	7.31 ^a
T7	Control 3 (10% Fat)	7.55 ^b	6.71 ^B	7.01 ^{aAB}	6.92 ^{cA}	6.12 ^{bB}	7.49 ^a	7.17 ^{aB}
T8	0.25M, 10% Fat	6.41 ^b	6.54 ^B	6.78 ^B	6.17 ^a	6.86 ^{ab}	6.52 ^{ab}	5.93 ^b
T9	0.5M,10% Fat	5.76 ^b	6.34 ^{AB}	6.96 ^{AB}	6.50 ^b	6.34 ^b	5.83 ^b	5.85 ^b

Values are presented as means. Values with different lowercase superscript within the same column are significantly different ($P < 0.05$) while values with different uppercase superscript within the same row are significantly different ($P < 0.05$).

4. Discussion

This study presents a novel investigation of consumers' perception of incorporating *Moringa oleifera* leaf meal (MOLM) and fat in chicken droëwors. The effect of the MOLM and various fat levels on the chicken's sensory attributes is presented in Table 2. The highest consumer preference for all sensory attributes was observed in droëwors samples with 0.25% of *Moringa oleifera* leaf meal (MOLM). Similar results were reported where the highest consumer preference for sensory attributes was observed when 0.25% of MOLM was added to produce herbal chicken sausages (Jayawardana *et al.*, 2015). The consumers responded with the highest preference in the overall preference. Increasing MOLM percentages above 0.5% may negatively affect the sensory characteristics of the chicken droëwors (Jayawardana *et al.*, 2015). The negative effect of MOLM on the acceptability of the product could be attributed to changes in the colour of the droëwors. The addition of MOLM significantly affected the colour parameter of the chicken droëwors. This is because MOLM has a dark colour, which could lead consumers not to accept the product. These results agree with the results reported where *Gleditsia sinensis* Lam. extract effect on physicochemical properties of emulsion-type pork sausages was investigated. *Gleditsia sinensis* Lam. extract significantly impacted the emulsion-type pork sausage's colour, due to the colour *Gleditsia sinensis* Lam. has such as reddish brown, or reddish-purple (Jin *et al.*, 2017). In terms of colour when 0.5% MOLM was added, consumers responded with low values, 6.74 and 6.14 in T3 and T9, respectively, compared to other treatments. This may be due to the quantity of MOLM added, which changed the product's colour to dark. Also, the chicken droëwors could be rejected by the consumers because the product's appearance and colour are vital standards that impact the consumer's buying decisions. It shows the cleanness of the product. The current results are also similar to the results obtained in a study of the effects of sweet basil leaf powder on the sensory and dietary qualities of beef and frankfurter sausages. The study found that basil leaves powder's inclusion resulted in a significant change in the sausages' colour (Abu *et al.*, 2019).

Regarding texture, the consumer's panel in the current study responded with lower values (T3 = 6.35, T6 = 6.74, T9 = 5.81) when 0.5% MOLM was added. This result thus shows that the texture of chicken droëwors was not good for the consumers. There are no studies of chicken droëwors mixed with *Moringa oleifera* leaf meal and fat; hence direct comparison cannot be drawn. However, in another study where plant extracts of *Gleditsia sinensis* Lam were used, when 0.05% of *Gleditsia sinensis* Lam. extract was added to

meat emulsion, the high amount of phenolic compounds responded with the protein thiols, avoiding the protein disulfide bonds. Therefore, poor protein networks were formed in the emulsion, leading to texture deterioration (Jin *et al.*, 2017). Generally, lipid oxidation in meat products impacts sensory characteristics, including texture, colour, flavour, and aroma. Thus, natural antioxidant use is considered a promising result in the sensory assessment of meat products. However, in the current study, 0.5% MOLM inclusion tended to lower the sensory score in chicken droëwors. The negative effect of MOLM at a 0.5% inclusion rate in the current study could likely be due to the high inclusion level of the leaf (Jin *et al.*, 2015).

Consumer's perception of chicken droëwors in this study was found to give higher ($P < 0.05$) scores in most sensory characteristics, denoting that chicken products are more acceptable (Table 3). Other studies agree with the current research that adequate addition of MOLM (0.25% according to the present study) positively influences meat products' acceptability (Moyo *et al.*, 2014). Consumers preferred the texture of droëwors when 0.25% MOLM was added. Therefore, adding *Moringa oleifera* leaf meal in chicken droëwors enhanced sensory attributes and can therefore be added and sold as a natural additive in the meat industry.

5. Conclusion

The current identified colour as the most observed sensory assessment parameter. When *Moringa oleifera* leaf meal (MOLM) was included at 0.25%, the study recorded the highest consumer preference for all sensory attributes. On the contrary, a negative texture score was recorded when MOLM was included at 0.5% suggesting that the colour was not appealing to consumers. Nonetheless, we conclude that *Moringa oleifera* leaf meal (MOLM) positively impacted the chicken droëwors, although more effective at a lower inclusion level. Based on the results, MOLM can be included in the meat processing industry because of the positive impact on the processing of meat products. The inclusion of *Moringa oleifera* leaf meal (MOLM) chicken droëwors improved all the sensory attributes of chicken droëwors in all treatments. Consumer sensory scores significantly increased as the level of MOLM inclusion in the chicken droëwors increased. Significant ($P < 0.05$) differences were observed in all sensory attributes due to MOLM and fat inclusion.

Conflict of interest

The authors declare no conflict of interest.

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