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Effect of Incorporation of Potato Dried Powder on the Quality Characteristics of Spent Broiler Breeder Hen Chicken Koftas

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ABSTRACT

The present study was carried out during July-October, 2022 in Department of Livestock Products Technology, College of Veterinary Science, Tirupati, Andhra Pradesh, India to evaluate the effect of different levels of potato dried powder on the quality characteristics of chicken koftas. The potato dried powder was incorporated at three different levels viz. 2, 4 and 6% in the formulation. The products were analyzed for various physicochemical (pH, emulsion stability, cooking yield, water holding capacity, proximate analysis) and sensory attributes. pH, emulsion stability, cooking yield, water holding capacity, moisture and crude fibre content of the products showed significant ($p<0.05$) increasing trend with increase in levels of incorporation of potato dried powder. However, a significant ($p<0.05$) decrease in the crude protein, ether extract and ash content of the chicken koftas was observed with increasing levels of incorporation. However, 4% potato dried powder incorporated spent broiler breeder hen chicken koftas scored significantly ($p<0.05$) better for all sensory attributes such as appearance, flavour, juiciness, texture and overall acceptability. Spent broiler breeder hen chicken koftas incorporated with 6 and 2% level of vegetable dried powders scored significantly ($p<0.05$) lower scores for all sensory attributes than 4% level of incorporation. Hence incorporation of potato dried powder at 4% level in chicken koftas was considered to be optimum.

KEYWORDS: Chicken koftas, physicochemical parameters, potato dried powder, sensory

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Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

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1. INTRODUCTION

Today, chickens represent by far the most important poultry species (about 90% of the poultry population), including mainly laying chicken (hens) for egg production and broilers for meat production (Alders, 2004). In 2019, the global chicken population was estimated to be over 25 billion; more than 6 billion are laying hens including both in rearing and in production, contributing to an average annual egg production of more than 70 mt over the last decade (Anonymous, 2021; Pym, 2013; Shahbandeh, 2021).

Spent broiler breeder hens produce commercial broilers with high hybrid vigour for meat production. Spent hen meat is tough, rubbery and has poor functional properties, due to more collagen content and inter-molecular cross linkages. About 2.6 billion spent hens were used in the pet food industry globally (Navid et al., 2011). Spent hens have an important place in Indian culinary practices for human consumption after the end of economic laying cycle (Mendiratta et al., 2012). Spent hen meat is a good source of nutrients such as proteins and omega-3 fatty acids (Chueachuaychoo et al., 2011) and lower in cholesterol content in particular breast muscle (Ajuyah et al., 1992) which have been shown to have health promoting benefits. Spent hen meat is more suitable for preparing value added or convenience products (Kondiah, 2010) and the undesirable characteristics of these meats may not be reflected in final products due to non-meat ingredients (Rhee et al., 1999). Spent hen meat (i.e., meat produced from old and culled birds after completion of their egg laying period) is primarily used in comminuted ground^{-1} meat products because of inherent toughness of spent hen meat, which can be removed through mincing grinding^{-1} process.

Vegetables occupy an important role in human nutrition as they provide essential minerals, vitamins and are also known to contain large amount of dietary fiber and phytochemicals that are natural antioxidants (Xu, 2001). Vegetables could also serve as fillers, binders, fat replacers and sources of dietary fiber and natural antioxidants in a meat system (Hedrick et al., 1994). Potatoes (*Solanum tuberosum* L.) are one of the most important staple crops for human consumption, together with wheat, rice and corn. India occupies the third place in the global production (Anonymous, 2019). Potato has excellent food qualities such as water, carbohydrates, starch, proteins and contains negligible fat (Mollick et al., 2020). Potato has long been used by meat processors and can be processed into starches and flour which can be used as a binder or extender to increase water binding and improve cooking yield (Berry, 1997 and Hughes et al., 1998). The water-binding of potato flour in emulsion type sausages is dependent of its content in the formulation (Sagi et al., 2023). Also, it considered as good source of carbohydrates, proteins, which contain amino acids that fulfilled human requirements, phosphorus, iron, calcium, vitamin C, B1 and B2, and has high protein calorie ratio (Gopalan et al., 2010). Potato also contains antioxidants as phenolic acids, ascorbic acid and carotenoids (Gumul et al., 2011). The antioxidant property helps in protecting the body from diseases by scavenging harmful free radicals from the body (Lixandru, 2020).

Keeping in view all the above facts the present study was envisaged to attempt the utilisation of potato dried powder in the development of spent broiler breeder hen chicken koftas. A study was designed to evaluate the effect of different levels of potato dried powder on the physicochemical properties and sensory profile of chicken koftas.

2. MATERIALS AND METHODS

The present study was carried out in Department of Livestock Products Technology, College of Veterinary Science, Tirupati, Andhra Pradesh, India during July–October, 2022. Spent boiler breeder birds (females) of 72 weeks age were purchased from local market, transported and slaughtered at the Department of Livestock Products Technology, College of Veterinary Science, Tirupati. Slaughter and dressing was performed as per the standard procedure. After marinating overnight in a chiller, the carcasses were hand-deboned and the meat was kept in freezer (-18±1°C) until further use.

2.1. *Spice mix*

The spice ingredients purchased from local market were cleaned thoroughly and dried in a hot air oven at 50°C for 60 min. The ingredients were ground separately in a blender (Model: Panasonic MX-AC 3005) and sieved through a fine mesh. The powders were mixed in suitable proportions to obtain the spice mix and were stored at room temperature in air tight container for further use. The formulation of spice mix prepared is as follows:

Composition of dry spice mix

Sl. No.	Spice variety	Part (g)
1.	Aniseed	100
2.	Ajwain (Carom seed)	100
3.	Black pepper	100
4.	Cardamom	50
5.	Cinnamon	50
6.	Cloves	50
7.	Cumin	100
8.	Dry ginger	70
9.	Nut meg	20

Composition of dry spice mix		
Sl. No.	Spice variety	Part (g)
10.	Red chillies	100
11.	Turmeric	100
12.	Coriander	160
Total		1000

2.2. Condiment mix

Green condiments such as onion and garlic in the ratio of 3:1 were used in this study. The external covers of onion and garlic were peeled off, washed thoroughly under running tap water and made into small pieces. The cut pieces were ground in a mixer-cum-grinder to the consistency of mix.

2.3. Non-meat ingredients

Non meat ingredients like refined sunflower oil, corn flour, sugar, salt and poly phosphate required for the preparation of chicken koftas was purchased from local market.

2.4. Preparation of potato dried powder

Fresh potatoes were procured from the local market of Tirupati. The potatoes were washed to remove adhering dirt, after draining off excess liquid vegetables were sliced, then dried in hot air oven at 60±5°C until brittle. The dried slices were grounded to fine powder and sieved.

2.5. Method of preparation of chicken koftas

Preliminary trials were conducted to optimize the basic formulation and processing conditions for the preparation of chicken koftas. The deboned meat was thoroughly screened for removing excess fat, tendon, etc. After adequate thawing in room temperature, meat was weighed, cut into small chunks and placed in the meat mincer. Meat mincing was done by 6 mm diameter plate and subsequently by 4 mm diameter plate (Sirman TC12E). The minced meat was then chopped in a bowl chopper. Ingredients were used as per the formulation given in Table 1. After preparing emulsions, small koftas weighing approximately 20 g were prepared and were deep fat fried till the desired brown color and an internal temperature of 72°C was attained.

2.6. Analytical procedures

2.6.1. pH

The pH of cooked chicken koftas was determined by the method of Trout et al. (1992) using digital pH meter (Systronics µ pH system 361, Model: 7856, Type 361)

2.6.2. Cooking yield

The weight of each koftas were recorded before and after cooking. The cooking yield was calculated and expressed as percentage by a formula:

$$\text{Cooking yield (\%)} = \frac{\text{Weight of cooked product}}{\text{Weight of raw product}} \times 100$$

Table 1: Formulations of spent broiler breeder hen chicken koftas fortified with potato dried powder at different levels

Ingredients	Control	Spent broiler breeder hen chicken koftas fortified with potato dried powder		
		T_1	T_2	T_3
Spent broiler breeder hen chicken meat	90	90	90	90
Potato dried powder	-	2	4	6
Vegetable fat	10	10	10	10
Salt	2	2	2	2
Sugar	1	1	1	1
Poly phosphate	0.3	0.3	0.3	0.3
Dry spice mix	2	2	2	2
Wet condiment mix*	3	3	3	3
Binder (corn flour)	3	3	3	3
Ice flakes	10	10	10	10

*Onion: Garlic paste (3:1); T_1: 2% potato dried powder; T_2: 4% potato dried powder; T_3: 6% potato dried powder

2.6.3. Emulsion stability and water-holding capacity (WHC)

Emulsion stability of meat emulsion was determined as per procedure described by Townsend et al. (1968). Water-holding capacity (WHC) was determined according to Wardlaw et al. (1973).

2.6.4. Proximate analysis

Moisture, crude protein, crude fibre, crude fat and total ash contents in both treatment samples and control were determined by using standard procedures prescribed by Anonymous (2002).

2.6.5. Sensory evaluation

The sensory evaluation of the products was carried for various attributes namely appearance and colour, flavour, juiciness, texture and overall acceptability by a panel of seven trained members composed of scientists and research scholars of the division based on a 8-point descriptive scale, wherein 8 denoted "extremely desirable" and 1 denoted "extremely undesirable" by Keeton (1983) with slight modifications.

2.6.6. Statistical analysis

Means and standard errors were calculated for different parameters. Data obtained in the study were analyzed statistically on 'SPSS-16.0' software package as per standard methods (Snedecor and Cochran, 1995). Duplicate samples were drawn for each parameter and the experiment was replicated thrice (n=6). Data were subjected to one way analysis of variance among the treatments.

Table 2: Effect of incorporation of different levels of potato dried powder on the physico-chemical properties of spent broiler breeder hen chicken koftas (Mean±SE)

Parameters	Control	Spent broiler breeder hen chicken koftas incorporated with potato dried powder		
		T_1	T_2	T_3
pH	6.00±0.006[a]	6.05±0.010[b]	6.15±0.012[c]	6.35±0.012[d]
% Cooking yield	87.57±0.010[a]	91.88±0.021[b]	92.91±0.021[c]	94.22±0.043[d]
% Emulsion stability	87.76±0.012[a]	92.66±0.010[b]	93.43±0.017[c]	94.58±0.008[d]
% Water holding capacity	49.64±0.011[a]	52.05±0.015[b]	54.56±0.032[c]	55.49±0.043[d]

(p<0.05): Means bearing at least one common superscript in the same row do not differ significantly; T_1: 2% potato dried powder; T_2: 4% potato dried powder; T_3: 6% potato dried powder

3. RESULTS AND DISCUSSION

The mean values of various physicochemical parameters namely pH, cooking yield, emulsion stability, water holding capacity and proximate composition of chicken koftas incorporated with 2, 4 and 6% levels of potato dried powder presented in Table 2 and 3.

3.1. pH

A significant (p<0.05) increase in pH was observed in the product with the increase in the level of incorporation of potato dried powder with the highest mean value recorded by T_3 koftas (products incorporated with 6% potato dried powder). This might be attributed to the fact that, in the cooking range of 55–80°C, new cross linkages are formed along with loss of free acidic groups from meat protein (Reddy and Vijayalakshmi, 1998). The results were correlated with the finding of Yilmaz and Daglioglu (2003) in beef meat balls, Ponsingh et al. (2010) in buffalo sausages and Chetana et al. (2014) in chicken cutlets.

3.2. Cooking yield

A significantly (p<0.05) increasing trend was observed in the cooking yield of the chicken sausages with increasing levels of potato dried powder. This could be due to swelling properties of dietary fiber and starch in potatoes (Ergezer et al., 2014). Similar results was reported by Ali et al. (2011) in beef patties and Ikhlas et al. (2011) in quail meat balls.

3.3. Emulsion stability

The mean percent emulsion stability increased significantly (p<0.05) in treated koftas as compared to that of control and highest values were recorded by T_3 koftas compared to others. This might be attributed to high starch content of potato flour and binding of greater amounts of water favouring stable emulsion formation (Lee et al., 2008 and Choi et al., 2009). Similar findings were reported by Bhat and Pathak (2011) in chicken seekh kababs and Verma et al. (2015) in pork patties.

3.4. Water holding capacity

The mean percent water holding capacity followed a significant (p<0.05) increasing trend with increase in levels of potato dried powder which might be due to the ability of starch in potato to absorb and keep more of water. As a result, a much more stable meat protein matrix was formed which leads to a smaller release of water and fat thus improving binding properties (Pietrasik and Shand, 2003). T_3 koftas recorded significantly (p<0.05) higher water holding capacity values compared to T_1, T_2 and control. This

Table 3: Effect of incorporation of different levels of potato dried powder on the proximate composition of spent broiler breeder hen chicken koftas (Mean±SE)

Parameters	Control	Spent broiler breeder hen chicken koftas incorporated with potato dried powder		
		T_1	T_2	T_3
% Moisture	64.65±0.047[a]	66.37±0.023[b]	67.53±0.041[c]	68.96±0.031[d]
% Crude protein	20.86±0.043[d]	20.07±0.03[1c]	19.45±0.075[b]	19.13±0.023[a]
% Crude fibre	0.64±0.013[a]	2.09±0.015[b]	3.07±0.031[c]	3.20±0.013[d]
% Crude fat	11.01±0.022[a]	13.18±0.043[c]	12.27±0.020[b]	12.32±0.062[b]
% Total ash	2.23±0.032a	2.69±0.091b	2.53±0.019b	2.29±0.06a

(p<0.05): Means bearing at least one common superscript in the same row do not differ significantly; T_1: 2% potato dried powder; T_2: 4% potato dried powder; T_3: 6% potato dried powder might be due to the fact that higher levels of flour retains more water, thereby increasing the water holding capacity (Reddy et al., 1999). These results were in accordance with Ergezer et al. (2014) in low fat beef meat balls.

3.5. Proximate composition

3.5.1. Moisture

A significant (p<0.05) increase was recorded in moisture percent with increasing level of incorporation of potato dried powder and highest values were recorded by T_3 koftas than others. This increase in moisture might be due to the ability of fat replacer to bind water (El-Beltagy et al., 2007). The treated spent broiler breeder hen chicken koftas lost significantly (p<0.05) less moisture during cooking than control, this could be explained as due to increase in the water holding capacity of the ingredients to bind water (Mansour and Khalil, 1997). These results were in concurrent with Mansour (2003) in beef burgers and Ergezer et al. (2014) in low fat beef meat balls.

3.5.2. Crude protein

The mean percent crude protein values of spent broiler breeder hen chicken koftas were significantly (p<0.05) decreased with increase in levels of potato dried powder. T_1 koftas recorded significantly (p<0.05) higher crude protein values compared to T_2 and T_3. This might be due to high starch and low protein content in potato (Chetana et al., 2014). These results are in agreement with Chetana et al. (2014) in chicken cutlets and Mousavi et al. (2021) in chicken frankfurters.

3.5.3. Crude fibre

The mean percent crude fibre values of spent broiler breeder hen chicken koftas incorporated with potato dried powder were increased significantly (p<0.05) with increase in the levels of potato dried powder incorporation. T_3 koftas recorded significantly (p<0.05) higher crude fibre values compared to T_1 and T_2. This might be due to high fibre level present in potato dried powder (Buzera et al., 2023). Similar increase in the crude fibre content was also observed by Verma et al. (2013) in mutton nuggets and Zargar et al. (2017) in chicken sausages.

3.5.4. Crude fat

The mean percent crude fat values of spent broiler breeder hen chicken koftas incorporated with different levels of potato dried powder were significantly (p<0.05) higher compared to the control. This might be due to the swelling property of the potato starch may interact with the protein of the ground meat matrix thereby acting to prevent migration of fat from the product (Anderson and Berry, 2001). Among the treatments, T_1 recorded higher percent crude fat compared to other levels. This could be due to presence of very low-fat percent (0.1%) in the potato dried powder as compared to the added meat (Weiss et al., 2010). Similar results were reported by Chetana et al. (2014) in chicken cutlets and Ergezer et al. (2014) in low fat beef meat balls.

3.5.5. Total ash

The mean percent total ash values of spent broiler breeder hen chicken koftas incorporated with potato dried powder significantly (p<0.05) higher compared to control and T_1 koftas recorded significantly (p<0.05) higher values than others. Many researchers have observed that ash content increases significantly (p<0.05) when adding dietary fiber to meat products from natural sources, as natural dietary fiber contain minerals and vitamins (Choi et al., 2009 and Choi et al., 2012). These results were in agreement with Ali et al. (2011) in low fat beef patties.

3.5.6. Sensory attributes

The mean values of various sensory parameters namely appearance, flavour, juiciness, texture and overall acceptability of chicken koftas incorporated with 2, 4 and 6% levels of potato dried powder were presented in Table 4. A significant (p<0.05) effect was observed on the appearance and flavour

Table 4: Effect of incorporation of different levels of potato dried powder on the sensory evaluation of spent broiler breeder hen chicken koftas (Mean±SE)

Parameters	Control	Spent broiler breeder hen chicken koftas incorporated with potato dried powder		
		T_1	T_2	T_3
Appearance	7.14±0.008^c	7.10±0.006^b	7.11±0.011^b	6.86±0.011^a
Flavour	6.83±0.011^c	6.75±0.014^b	6.76±0.006^b	6.66±0.015^a
Juiciness	7.00±0.004^b	7.13±0.006^c	7.23±0.011^d	6.76±0.012^a
Texture	7.00±0.024^b	7.14±0.017^c	7.34±0.011^d	6.83±0.013^a
Overall acceptability	7.07±0.030^b	7.16±0.012^c	7.20±0.014^c	6.60±0.015^a

(p<0.05): Means bearing at least one common superscript in the same row do not differ significantly; T_1: 2% potato dried powder; T_2: 4% potato dried powder; T_3: 6% potato dried powder scores of the products. The scores for appearance and flavour for T_2 koftas (products incorporated with 4% potato dried powder) were significantly (p<0.05) higher than control and other treatments whereas the T_1 and T_2 koftas were comparable with each other. This might be attributed to dilution of myoglobin concentration and presence of starchy flavour (Trout et al., 1992 and Kumar et al., 2013). These observations were in agreement with the findings of Muthia et al. (2010) in duck sausages, Ergezer et al. (2014) in low fat beef meat balls and Singh et al. (2014) in chevon cutlets.

The mean juiciness scores were significantly differed (p<0.05) between formulations. T_2 koftas recorded significantly (p<0.05) higher mean juiciness scores followed by T_1, control and T_3. This could be attributed to higher water binding properties of potato starch making moisture unavailable for early juice release during mastication (Berry and Wergin, 1993). This was in agreement with Ergezer et al. (2014) in low fat beef meat balls.

The mean texture scores were significantly differed (p<0.05) between treatments and control. T_2 koftas recorded significantly (p<0.05) higher texture scores and T_3 recorded significantly (p<0.05) lower scores compared to other treatments and control. This might be due to extensively hydrated starch granules, which opened the fibrous structure of meat product (Khalil, 2000 and Mansour, 2003). These results were in accordance with Singh et al. (2014) in chevon cutlets.

The mean overall acceptability scores were significantly differed (p<0.05) between treatments and control. T_2 koftas recorded significantly (p<0.05) higher overall acceptability scores than T_3 and control. However, T_1 and T_2 koftas were not differed significantly (p>0.05). This might be due to the fact that T_2 koftas recorded significantly (p<0.05) higher scores for colour, flavour, juiciness and texture that might have influenced the panelists to rate high for overall acceptability also (Chandralekha et al., 2012). The findings of the present study were well in agreement with the reports of Chetana et al. (2014) in chicken cutlets.

4. CONCLUSION

The present study showed successful utilization of potato dried powder for the development of spent broiler breeder hen chicken koftas. The potato dried powder could be efficiently utilized for the preparation of spent broiler breeder hen chicken koftas with good nutritive value and well acceptability.

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