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ORIGINAL ARTICLE

Effect of Dried Carrot Powder Incorporation on Quality Attributes of Chicken Cutlets

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Abstract

Present investigation was undertaken to explore the possibilities of utilization of carrot pomace dried powder in chicken cutlets prepared from broiler chicken meat. The study was conducted to assess the effect of different levels (0%, 2.5%, 5%, 7.5% and 10%) carrot pomace dried powder incorporation on physico-chemical, textural properties and sensory attributes of chicken cutlets with its control counterpart. Incorporation of different level of carrot pomace dried powder in chicken cutlets significantly (P<0.05) increased in moisture content, ash, crude fibre, cooking yield, pH, water holding capacity and beta-carotene. Decreased (p<0.05) protein, fat, shrinkage and cholesterol were found with increasing dried carrot powder inclusions. Addition of carrot pomace dried powder as a filler material improved both the mineral and vitamin contents and resulted in chicken cutlets with improved textural properties and sensory acceptability scores. Hence, developing value added meat products with suitable formulation having low cost is very much required to be reached to consumers.

Keywords: Dried carrot powder, Physico-chemical properties, Sensory quality, Textural properties.

1. Introduction

Chicken meat plays an important role in diet as it contributes macro and micro nutrients required for the growth and maintenance of human health. High cost of meat is a major stumbling block for consumer's who would like to relish highly nutritious, tastier meat products regularly. Recent trend in meat industry is development of value added communited meat products to reduce the cost and improve the yield and product quality due to unabated upward price trend of broiler chicken (Ahlawat *et al*., 2012).

The non-meat ingredients are extensively incorporated as extenders, binders and fillers viz; soya products, egg products, flour made from durum wheat, rice, mashed potato, dairy products and by-products in comminuted meat products to improve the quality attributes and reduce the production loss (Yadav *et al.*, 2013). Fillers are mostly plant substances, low in protein and high in carbohydrates such as cereals, roots, tubers and vegetables and some refined products such as starches and flours (Mendiratta *et al*., 2013).

Carrot (*Daucus carota*) is a root vegetable, usually orange, purple, red, white or yellow in color, with a crisp texture and a rich source of β-carotene and contains other vitamins, like thiamine, riboflavin, vitamin B-complex and minerals (Walde *et al.*, 1992). Carrot is also an excellent source of calcium pectate; an extraordinary pectin fiber that has the cholesterol lowering properties. It has a property to reduce the risk of high blood pressure, stroke, heart disease and some type of cancer (Bakhru, 1993). Carrot pomace is a by-product obtained during carrot juice processing. The juice yield in carrots is only 60-70%, and even up to 80% of carotene may be lost with left over carrot pomace (Bohm *et al.*, 1999). As the fiber-rich pomace is available in large quantity during juice production, it is worth exploiting the carrot insoluble fiber-rich fractions (IFRF) as a promising hypocholesterolemic ingredient to fulfill the increasing demand of functional ingredients in developing fiber-rich food products with a good residual amount of all the vitamins, minerals and dietary fibre.

In recent studies, Saleh and Ahmed (1998), reported that incorporation of boiled carrot (100 g/ kg meat) improved the colour, texture and nutritive value of beef patties; whereas, carrot powder improved cooking yield, colour, texture and vitamin-A content. In another study, Devatkal *et al.* (2004) prepared vegetable-liver loaf by incorporating 40% carrot and potato in ratio on 1:1 with acceptable sensory scores; while the addition of 2% natural carrot fibre in pork sausages improved the water binding capacity (Werner *et al.*, 2002). Eim *et al.* (2008) prepared sobrassada with 3% added carrot had higher acceptability for various physico-chemical and sensory attributes but its textural parameters were significantly affected.

However, health conscious consumers demand low level of fat, cholesterol and higher dietary fibers in meat products. The incorporation of fruits and vegetables as non-meat ingredients in processed meat products is the possible solution to the recent consumers demand for low fat and high fibre meat products due to their natural antioxidant activity, fibre and nutrient contents (Yue, 2001). Hence, the present investigation was carried out to assess the effect of different levels of carrot pomace dried powder incorporation as filler on quality attributes of chicken cutlets.

2. Material and Methods

2.1 Raw Materials and Preparations

Cornish breed broiler chickens of 6 weeks age; carefully selected from same age and feeding group were procured from Instructional Poultry Farm, G. B. Pant University of Agriculture and Technology, Pantnagar. The chickens were slaughtered and dressed as per approved scientific methods at the experimental slaughter house of Department of Livestock Products Technology, College of Veterinary and Animal Sciences, G. B. Pant University of Agriculture and Technology, Pantnagar. Dressed carcasses were chilled at 4 ± 1º C for 4-5 hours and deboned manually; deboned meat was packed in LDPE bags and stored at -18 ± 1º C till further use. Partially thawed meat was cut into small pieces and grounded twice in a meat mincer (Hobart®, USA) with 6 mm plate followed by 3 mm plate.

Carrots were freshly procured from local market and washed in running tap water to remove impurities. Trashes were removed with a plane stainless steel knife and then trimmed with the same knife**.** The juice was extracted using a Juice Mixer Grinder cum Food Processor (Make: Maharaja Whiteline, Asiatic Engineers Pvt. Ltd., 600W) as per the process developed by Goyal (2004). The pomace was collected and blanched at 55 ± 2º C for 5 minutes, then dried at 60 ± 2° C temperatures with air velocity of 1.0 m/ s for 12 hours in a forced convection drier as thin layer with thickness of about 5 mm. The grinding of dried carrot pomace was performed using the same food processor (Make: Maharaja Whiteline, Asiatic Engineers Pvt. Ltd., 600W) with grinder attachment; up to a level of passing through the sieve of 2 µm size. The carrot pomace dried powder was stored in sealed LDPE bags till the further processing.

All the chemicals used in the study were of analytical and food grade, purchased from standard firms (Hi media, Merck). In experimental trials carrot pomace dried powder was incorporated at 0%, 2.5%, 5%, 7.5% and 10% levels proportionately. Other ingredients were salt (2%), dried spice mix (2.5%), ice (5%) and green curry stuff (5%; in ratio of onion, garlic and ginger paste; 10: 3: 2). Meat batter was prepared by mixing with stationary meat mixer (Hobart®, USA) of all the ingredients in the mentioned proportion in Table 1, separately for each group. The batter was moulded into the shape of cutlets by product shape forming machine (Hobart®, USA). The moulded cutlets were deep fried in refined soyabean oil at 160 ± 4º C for 4-5 minutes till an internal temperature reached upto 85 ± 2º C and turned repeatedly to avoid charring.

Abbreviations used for control and treatments are as follows: 0% carrot pomace dried powder was added to control (C), 2.5% carrot pomace dried powder ($T_{2.5}$), 5.0% carrot pomace dried powder added (T_5), 7.5% carrot pomace dried powder added ($T_{7.5}$) and 10% carrot pomace dried powder added (T_{10}), respectively.

2.2 Analytical Procedures

2.2.1 Physico-Chemical Attributes

Moisture, fat, protein, ash and crude fibre content of chicken cutlets were determined by as per procedure of AOAC (2000). The pH of homogenated representative samples was recorded by using a digital pH meter (WTW®, Germany, Model 330i fitted with Sen Tix sp electrode) by immersing the electrode of pH meter into aliquot of the sample. Water holding capacity (WHC) was determined as per procedure described by Wardlaw *et al.* (1973). Total cholesterol was determined as per procedure described by Rajkumar *et al*. (2004). Weight of raw and cooked cutlets was recorded to calculate cooking yield (%). Length, breadth and thickness (cm) of raw and cooked cutlets were recorded to determine shrinkage (%) with the formula suggested by El-Magoli *et al*. (1996).

$$\text{Shrinkage (\%)} = \frac{(\text{Raw thickness–Cooked thickness}) + (\text{Raw diameter-Cooked diameter})}{(\text{Raw thickness + Raw diameter})} \times 100$$

Table 1: Composition for formulation of chicken cutlets using carrot pomace dried powder as filler

Ingredients	Control	$T_{2.5}$	T_5	$T_{7.5}$	T_{10}
Chicken Meat (g)	1000	975	950	925	900
Carrot Pomace dried powder (g)	0	25	50	75	100
Dried Spices (g)	25	25	25	25	25
Salt (g)	20	20	20	20	20
STPP (g)	2.5	2.5	2.5	2.5	2.5
Sodium Nitrite (ppm)	150	150	150	150	150
Green curry stuff (g)	50	50	50	50	50
Ice (%)	5	5	5	5	5

2.2.2 β-Carotene

β-Carotene was estimated by method as suggested by Srivastava and Kumar (2003). 5g of sample of chicken cutlets was grinded with few crystals of anhydrous sodium sulphate and homogenized with 10 ml acetone. It was decanted and then supernatant was collected in a beaker. The process was repeated twice and transferred the combined supernatant to a separating funnel. 10 ml of petroleum ether was added and mixed thoroughly. Two layers were separated out on standing. Discarded the lower layer and collected the upper layer in 100 ml volumetric flask, volume was made up to 100ml with petroleum ether and optical density was recorded at 452 nm. Petroleum ether was used as blank. The β-carotene was then calculated using the following expression:

$$\beta\text{-Carotene } (\mu g/\ 100\ g) = \frac{\text{O.D. of sample x 13.9 x 104 x 100}}{\text{Weight of sample x 560 x 1000}}$$

2.2.3 Mineral Analysis

Mineral analysis of control and different levels of carrot pomace dried powder incorporated chicken cutlets was determined by energy dispersive X-ray spectra using a scanning electron microscope (JEOL JSM-6610LV). Chicken cutlets (1×1×1 cm^3) were cut and dried with liquid CO_2 upto the critical point for 60-90 minutes by using critical drier (EMITECH K850**),** after that samples were placed in vaccum chamber (BRUKER127eV) and high density electron beams passed through this, which produced specific X-ray for specific element. The specific X-ray was detected by attached silicon semiconductor probe, which analyses the concentration of elements/ minerals in per cent weight present in the samples.

2.2.4 Textural Attributes

The values of shear force was determined as force required for shearing 2 X 1 X 1 cm^3 block measured on Warner-Bratzler Shear force (Hot dog shearing probe SAU1, WBB, PRJ, using Stable Micro System, Model TA.XT2i/25, UK). Ten observations were recorded to obtain the average values of firmness and toughness for each trial. Texture profile analysis of chicken cutlets was conducted, using a texture analyzer (Stable Micro System, Model TA.XT2i/25 UK, using probe P/75 compression platen) attached to software (texture expert). Samples were sized to pieces of 1 cm^3 to be made as test samples. The samples were placed on a platform in a fixture and compressed twice to 75% of their original height by compression probe (P/75) at a cross head speed of 10 mm/ s through a two cycle sequence, using a 50 kg load cell.

2.3 Sensory Evaluation

Selection and training of sensory evaluation panellists were performed according to the procedure of Kumar *et al*. (2015); 8 panellists were selected from 20 potential panellists, using basic taste identification tests. They consisted of post-graduate students and faculty members of Department of Livestock Products Technology, College of Veterinary and Animal Sciences, Pantnagar (India), who were familiar with the characteristics of meat products. Three training sessions were held during preliminary trials before the initiation of this experiment. All sessions were done in an eight-booth sensory panel room at 22°C, equipped with white fluorescent lighting (230 V, 35 W). The sessions were held 3 hours after breakfast. Three-digit coded samples, two slices (1 cm thickness) of chicken cutlet (warmed in a microwave oven for 20 seconds) from each group were served on a round plate to the panellists in random order. Panellists were required to cleanse their palates between samples with clean water. The nature of the experiment was explained to the panellists without disclosing the identity of samples. The sensory panellists were asked to rate their preference on an eight-point descriptive scale (where 8 - extremely desirable, 1 - extremely undesirable) on the sensory evaluation proforma for different attributes (Keeton *et al*., 1983). The panellists judged the samples for appearance, flavour, texture, juiciness and overall acceptability.

2.4 Statistical Analysis

The experiment was replicated six times and the data generated were analyzed by statistical methods of one way ANOVA and Mean ± S.E. using SPSS version17 software package.

3. Results and Discussion

3.1 Physico-chemical Properties

The results of different physico-chemical properties of chicken cutlets influenced by different levels of carrot pomace dried powder incorporation are depicted in Table 2. Incorporation of increasing level of carrot pomace dried powder in chicken cutlets caused significant (P<0.05) increase in moisture, ash, crude fibre, cooking yield, pH, water holding capacity and β-carotene; whereas, a significant (P<0.05) decrease in protein, fat, shrinkage and cholesterol content were observed. This reduction might be attributed to the dilution effect caused by incorporation of carrot pomace dried powder which is particularly low in protein and fat content. Fillers like carrot pomace dried powder increase the juiciness of the product due to their high water absorption capacity. It may be also reason for increased values of moisture content, cooking yield and water holding capacity. These results were similar to Saleh and Ahmed (1998); found that incorporation of boiled carrot (100 g/ kg meat) improved the colour, texture and nutritive value of beef patties; whereas, carrot powder improved cooking yield, colour, texture and vitamin-A content. Decreased cholesterol is more likely due to the reduction in lean chicken meat in treatments with increasing carrot pomace dried powder inclusions. Decreased cholesterol content could be also due to presence of calcium pectate in carrot; an extra ordinary pectin fiber that has the cholesterol lowering properties (Bakhru, 1993). Improvement in water holding capacity was similar to Werner *et al.* (2002), reported that addition of 2% natural carrot fibre in pork sausages improved the water binding capacity.

3.2 Mineral Analysis

The results of mineral content in percent weight of dried chicken cutlets influenced by different levels of carrot pomace dried powder incorporation are expressed in Table 3; indicated that addition of higher carrot pomace dried powder in chicken cutlets formulation caused significant (P<0.05) increase in K, Ca, P, Fe, Cu, Zn and Mn content; whereas, increased Na content was also revealed but statistically non significant (P<0.05). This increased mineral content might be due to high content of many minerals including calcium, copper, magnesium, potassium, phosphorus and iron in carrot pomace.

3.3 Shear Force Value

The mean values for shear force of control and treatment groups are presented in Fig 1. The shear force values as firmness and toughness of chicken cutlets were significantly (P<0.05) increased with an increase in addition of carrot pomace dried powder in chicken cutlets formulation. Firmness and toughness values of chicken cutlets were revealed as lowest for control group and highest for T_{10} group. High amount of fibre in carrot pomace plays a role in the formation of firm three dimensional gel matrix which might be reason for increased shear force value.

3.4 Texture Profile Analysis

The mean values of chicken cutlets texture profile attributes for different levels of carrot pomace dried powder incorporation are presented in Table 4.

Table 2: Effect of different levels of carrot pomace dried powder incorporation on physico-chemical properties of chicken cutlets (Mean±SE)

Particulars	Control	$T_{2.5}$	T_5	$T_{7.5}$	T_{10}
Moisture (%)	59.77±0.276$^{e\$*}$	61.09±0.080^d	61.92±0.022^c	62.52±0.014^b	63.22±0.047^a
Protein (%)	29.46±0.317^a	28.40±0.187^b	27.94±0.097^b	26.98±0.049^c	25.94±0.107^d
Fat (%)	8.79±0.506^a	8.08±0.118^b	7.49±0.102b^c	7.40±0.044b^c	7.25±0.009^c
Ash (%)	1.36±0.031^e	1.53±0.013^d	1.66±0.016^c	1.93±0.007^b	2.14±0.039^a
Crude Fibre (%)	0.52±0.015^e	0.81±0.011^d	0.89±0.007^c	1.12±0.016^b	1.38±0.016^a
Cooking Yield (%)	85.82±0.140^e	88.09±0.090^d	89.17±0.128^c	90.24±0.235^b	90.84±0.058^a
Shrinkage (%)	17.70±0.262^a	17.58±0.130^a	15.86±0.224^b	14.38±0.225^c	11.96±0.248^d
pH	6.07±0.013^e	6.17±0.005^d	6.21±0.005^c	6.26±0.007^b	6.32±0.005^a
WHC (%)	34.59±0.155^e	35.74±0.180^d	37.25±0.091^c	38.81±0.053^b	40.20±0.089^a
Cholesterol (mg %)	75.04±0.416^a	71.65±0.290^b	68.86±0.248^c	65.87±0.228^d	62.40±0.333^e
β-Carotene (μg/ 100 g)	32.17±1.85^e	107.33±1.55^d	191.11±2.92^c	271.77±2.63^b	342.49±2.46^a

*Data in table represents Mean ± SE of 6 trials; *Values bearing different superscripts in same row differ significantly (P<0.05).*

Table 3: Effect of different levels of carrot pomace dried powder incorporation on mineral composition of dried chicken cutlets (Mean±SE)

Minerals	Control	$T_{2.5}$	T_5	$T_{7.5}$	T_{10}
Na (%)	$1.163±0.079^a$	$1.206±0.076^a$	$1.276±0.083^a$	$1.331±0.076^a$	$1.363±0.077^a$
K (%)	$0.225±0.011^d$	$0.255±0.009^{cd}$	$0.276±0.011^{bc}$	$0.300±0.016^{ab}$	$0.330±0.014^a$
Ca (%)	$0.203±0.011^e$	$0.246±0.008^d$	$0.280±0.003^c$	$0.335±0.007^b$	$0.336±0.006^a$
P (%)	$0.103±0.011^c$	$0.126±0.009^{bc}$	$0.143±0.004^b$	$0.173±0.006^a$	$0.196±0.010^a$
Fe (%)	$0.061±0.009^c$	$0.078±0.011^{bc}$	$0.096±0.012^{ab}$	$0.113±0.010^a$	$0.126±0.012^a$
Cu (%)	$0.028±0.004^d$	$0.043±0.005^c$	$0.053±0.004^{bc}$	$0.065±0.002^{ab}$	$0.075±0.002^a$
Zn (%)	$0.033±0.004^c$	$0.048±0.005^b$	$0.058±0.004^{ab}$	$0.065±0.005^a$	$0.068±0.005^a$
Mn (%)	$0.018±0.003^c$	$0.030±0.002^b$	$0.040±0.002^b$	$0.051±0.004^a$	$0.058±0.004^a$

*Data in table represents Mean ± SE of 6 trials; *Values bearing different superscripts in same row differ significantly (P<0.05).*

Table 4: Effect of different levels of carrot pomace dried powder incorporation on texture profile attributes of chicken cutlets (Mean±SE)

Particulars	Control	$T_{2.5}$	T_5	$T_{7.5}$	T_{10}
Hardness (N/ cm^2)	$2.343±0.157^d$	$2.265±0.102^d$	$2.927±0.198^c$	$3.768±0.074^b$	$4.893±0.183^a$
Adhesivene-ss (N.s)	$-0.014±0.004^{ab}$	$-0.031±0.010^a$	$-0.049±0.006^c$	$-0.006±0.002^b$	$-0.025±0.003^a$
Springiness (cm/mm)	$0.304±0.036^a$	$0.229±0.006^b$	$0.234±0.002^b$	$0.271±0.004^{ab}$	$0.263±0.016^{ab}$
Cohesiveness (Ratio)	$0.247±0.016^c$	$0.342±0.026^{ab}$	$0.306±0.005^b$	$0.301±0.017^b$	$0.382±0.014^a$
Gumminess (N/ cm^2)	$0.588±0.068^d$	$0.786±0.094^{cd}$	$0.894±0.049^{bc}$	$1.142±0.089^b$	$1.876±0.124^a$
Chewiness (N/ cm)	$0.191±0.041^a$	$0.181±0.024^a$	$0.209±0.009^a$	$0.311±0.028^b$	$0.486±0.018^a$
Resilience (Ratio)	$0.064±0.003^b$	$0.084±0.008^a$	$0.075±0.004^{ab}$	$0.071±0.003^{ab}$	$0.084±0.004^a$

*Data in table represents Mean ± SE of 6 trials; *Values bearing different superscripts in same row differ significantly (P<0.05).*

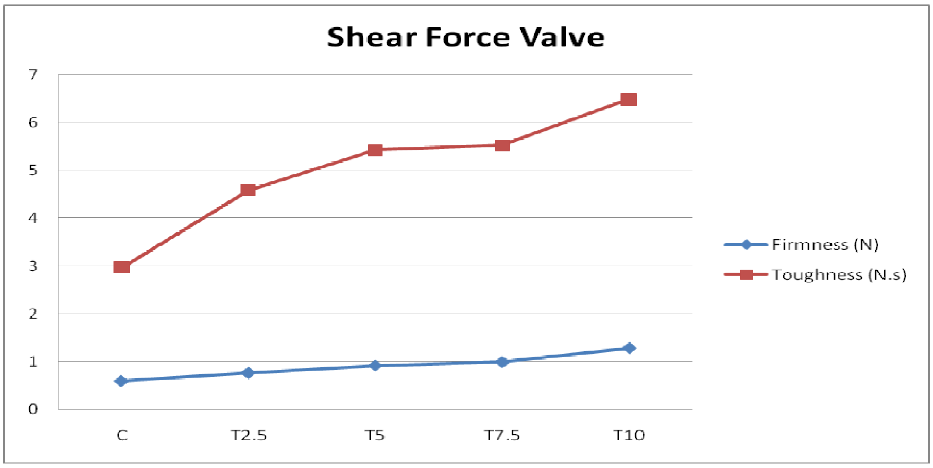

Fig 1: Effect of different levels of carrot pomace dried powder incorporation on shear force values of chicken cutlets (Mean±SE)

There was a significant (P<0.05) increase in hardness and gumminess with an increased level of carrot pomace dried powder in chicken cutlets; which might be due to crisp texture of carrot pomace dried powder. High amount of fibre in carrot pomace dried powder may be also reason for increased hardness and gumminess. The mean value of adhesiveness was found highest for $T_{2.5}$ and lowest for T_5. Springiness values revealed highest for control group. There was a significant (P<0.05) increase in cohesiveness with an

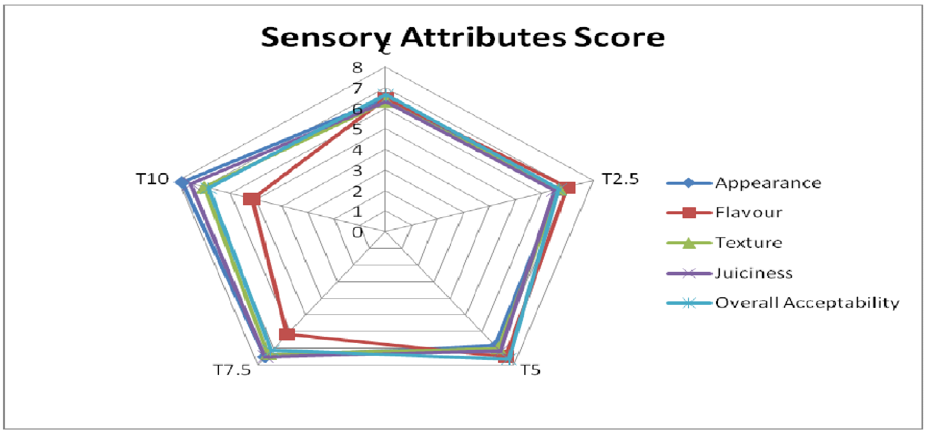

Fig 2: Effect of different levels of carrot pomace dried powder incorporation on sensory attributes of chicken cutlets

increased incorporation of carrot pomace dried powder in chicken cutlets but $T_{2.5}$ and T_{10} were not significantly (P<0.05) different. The value for chewiness of $T_{7.5}$ was found significantly (P<0.05) lower than other groups. The value for resilience revealed higher with an increased level of carrot pomace dried powder in chicken cutlets but value of $T_{2.5}$ and T_{10} were significantly (P<0.05) higher than control preparation.

3.5 Sensory Evaluation

Data pertaining to sensory attributes of chicken cutlets for different levels of carrot pomace dried powder incorporation are expressed in Fig 2; indicated that, chicken cutlets containing higher carrot pomace dried powder scored significantly (P<0.05) higher for appearance, texture and juiciness than the control preparation. The better appearance scores of higher carrot pomace dried powder containing cutlets might be due to increased reddish tint imparted by carrot pomace dried powder. Improvement in texture could be due to crisp texture of carrot pomace dried powder. Increased juiciness score with higher incorporated carrot pomace dried powder may be due to increased water binding capacity. These finding were similar to Saleh and Ahmed (1998), observed that incorporation of boiled carrot (100 g/ kg meat) improved the colour, texture. Decreased flavour scores in $T_{7.5}$ and T_{10} might be due to development of sweet taste imparted by higher amount of carrot pomace dried powder incorporation; which is not desirable in meat products. Overall acceptability was revealed significantly (P<0.05) higher for T_5 group among all groups.

4. Conclusion

It is concluded that developed chicken cutlets is nutritiously superior, highly acceptable and healthy at low cost. Incorporation of carrot pomace dried powder in chicken cutlets increased in moisture, ash, crude fibre content, cooking yield, pH, water holding capacity and beta-carotene; whereas, decreased in protein, fat, shrinkage and cholesterol content were revealed.

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