Effect of Using Beet Root Powder on Nutritional Value of Beef Kofta

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Abstract :

The objective of this study was to investigate the effect of using beet root powder on chemical composition, caloric value, sensory evaluation and physical properties of beef kofta. Beef meat was substituted with beet root powder as percentage of 3, 5 and 10% . Results indicated that beet root powder contained (6.77±0.01, 11.30±0.15 , 0.55±0.02, 3.65±0.01, 19.88±0.02 and 57.85±0.15 g/100g), respectively for moisture, protein, fat, ash, fibers and carbohydrates. Caloric value recorded (281.55±0.01k.cal / 100g.). Results revealed that substitution of beef meat with beet root powder increased the amount of ash, fibers ,decreased protein and fat content. All samples were accepted. Control recorded the highest value of taste , flavor, color and texture (9.60±0.51, 10.00±0.00, 9.50±0.52 and 9.20±0.78). Physical properties of beef kofta improved by using beet root powder. Control recorded the lowest value of weight before and after cooking, while control recorded the highest cooking loss value.

Key words :Beet root, beef kofta, chemical composition , sensory evaluation , caloric value and physical properties.

تأثير استخدام مسحوق البنجر على القيمة الغذائية للكفتة البقري

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الملخص العربي

الهدف من هذه الدراسة هو معرفة تأثير استخدام مسحوق البنجر على التركيب الكيميائي والقيمة الحرارية والتقييم الحسي والخصائص الفيزيائية لكفتة اللحم البقري. تم استبدال لحم البقر بمسحوق جذر البنجر بنسب ٣ و ٥ و ١٠%. أشارت النتائج الى أن مسحوق البنجر احتوى على (٦.٧٧± ٠.٠١ ، ١١.٣٠± ٠.١٥ ، ٠.٥٥ ± ٠.٠٢ ، ٣.٦٥ ± ٠.٠١ ، ١٩.٨٨ ± ٠.٠٢ ، ٥٧.٨٥ ± ٠.١٥ جم / ١٠٠جم على التوالي بالنسبة للرطوبة ، البروتين ، الدهون ، الرماد ، الالياف ، الكربوهيدرات . وقد سجلت السعرات الحرارية ٢٨١.٥٥ ± ٠.٠١ كيلوكالورى / ١٠٠ جم .أوضحت النتائج إلى أن استبدال لحم البقر بمسحوق جذر البنجر أدى إلى زيادة كمية الرماد والألياف وخفض محتوى البروتين والدهون. تم قبول جميع العينات.سجلت العينة الضابطة اعلى

قيمـــة للطعـــم والنكهـــة واللـــون والقـــوام (٩.٦٠±٠.٥١ ، ١٠.٠٠ ± ٠.٠٠ ، ٩.٥٠±٠.٥٢ و ٩.٢٠±٠.٧٨) .تحسنت الخصـائص الفيزيائيـة لكفتـة اللحـم البقـري باسـتخدام مسـحوق البنجـر. سجلت العينـة الضـابطة اقل قيمـة في الوزن قبل وبعد الطهى بينما سجلت العينـة الضـابطة اعلى قيمة في الفقد في الوزن .

الكلمات المفتاحية: جذور البنجر، الكفتة البقري، التركيب الكيميائي، التقييم الحسي، القيمة الحرارية والخصائص الفيزيائية.

Introduction:

The beetroot is a vegetable grown throughout the Americas, Europe, and Asia (**Desseva *et al*., 2020**). The world production in 2017 was 301 million tons, where Western Europe is the largest producer with about 70% of the total production (200 million tons) (**De Oliveira *et al*.,2020 and Kohajdová *et al*.,2018).** Most beetroot is consumed as a vegetable, although it is also consumed as juice and can be processed into a powder for use as a food coloring agent (**Kohajdová *et al*.,2018)**.The red beet (*Beta vulgaris*) contains bioactive phytochemicals, including polyphenols, flavonoids and other functional antioxidant compounds. Moreover, it is a source of water-soluble pigments known as betalains (62.04-118.92 mg in 100 g of vegetable (**Stagnari *et al*., 2014),** which can be split in two classes, betacyanins (red) and betaxanthins (yellow) and might be adopted as a natural food colorant. Beetroot peel carries the main portion (54%) of these compounds and the 50% of total phenolic content (**Kujala *et al*., 2000)**. Beetroot (*Beta vulgaris L.*) is an herbaceous biennial plant classified as one of the Chenopodiaceae family. The taproot found either in yellow pulp color or red (**Kale *et al*.,2018; Singh and Hathan, 2014 ; Srivastava and Singh, 2016)** where the red root utilized in salad, juice, food coloring and as a medicine (**Singh and Hathan,2014 and Biondo *et al*.,2014**) that emerged along the Mediterranean coast. Beets are considered as one of the most effective vegetables, they are a source of betalain pigment in addition to phenolic acids such as gallic, syringic and caffeic acids and flavonoids. It has anti-inflammatory, and antioxidant effects, which scavenge free radical from the cells promoting cancer prevention by inhibiting the tumor cells proliferation, reducing the risk of cardiovascular diseases and expelling kidney stones (**Kale *et al*.,2018**). Beetroot also considered as a good source of minerals such as iron, calcium, phosphorus, potassium, sodium, and zinc, in addition to vitamins like biotin, niacin, folate **(Vanajakshi *et al*., 2015)**.

Beetroot in its fresh form has high water content, thus it can be processed into powder form in order to enhance its shelf life. There is growing interest in the use of natural food colors, because synthetic dyes are becoming more and more critically assessed by the consumer. But in food processing, as compared with anthocyanins and carotenoids, betalains are less commonly used, although these water-soluble pigments are stable between pH 3 and 7. To improve the red color of tomato pastes, sauces, soups, desserts, jams, jellies, ice creams, sweets and breakfast cereals, fresh beet/beet powder or extracted pigments are used **(Koul *et al*., 2002; Roy *et al*., 2004 and Ibraheem *et al*., 2016)**.

Dincer *et al*., (2021) used four colorants (control, carmine, beetroot extract and beetroot extract powder) and two methods (fermentation and heat treatment) in the production of sausages. The study revealed that use of beetroot extract and powder significantly prevented further development of lipid oxidation in sausages due to the antioxidant properties of beetroot, with a prevalence of betalains and phenolic compounds. The modern technology in different fields gives chance for the meat processors to produce new products in different shapes, easily handled, stored and rapidly used .The need for meat products have many tasks includes new flavor, preservation and of low calories. The quality of raw material as well as the additives used in the final products is very important for public health (**Edris *et al*., 2012)**. The objective of this study is to evaluate the chemical composition of beet root powder , effect of using beet root powder at levels 3,5 and 10 % on chemical composition , caloric values , sensory and physical properties of beef kofta.

Materials and Methods

Materials:

Red beet root ((*Beta vulgaris L.*), beef meat and the other ingredients were purchased from the local market , Kafrelsheikh City, Egypt.

Methods:

Preparation of beet root powder

The fresh beetroots were obtained as raw material from the local market. After that, beetroot were washed with tape water to remove dust and sticky particles. Beetroot was peeled by using peeler (Tupperware) and then grated into slices by using grater (ROKKI).The sliced materials were allowed for sun drying completely (dehydrates) for 2 days. Then dehydrated beetroot pieces were grinded (MOULINEX, AR110010 grinder) and made into fine powder so that they can be stored for longer periods of shelf life.

Preparation of beef kofta

Kofta blend was prepared using the formula given by **Youssef, (1972)** as showed in Table (A). Meat 90% was mixed into house mincer (SONAII, SH-4000) with flour 3%,fresh onion 3% peeled and minced before the addition ,2% salt and 2% spices .These ingredients were mixed together, divided into four equal portions , the first equal was remained without any addition (control) and the three other portions were individually mixed with beet root powder at concentrations of 3,5 and 10% to give the treatments . Finger shaped pieces were prepared to formulate kofta, then cooked at 220°C in electric oven (Sharp EO 60 K).

Table (A). Formula of beef kofta (g/100 g)

Ingredients	Control	Formula (1)	Formula (2)	Formula (3)
Meat	90	87	85	80
Flour	3	3	3	3
Fresh onion	3	3	3	3
Salt	2	2	2	2
Species	2	2	2	2
Beet root powder	-----	3	5	10

Proximate chemical composition

Beet root powder and beef kofta were analyzed for chemical composition. All analyses were carried out in triplicate. Moisture, crude protein, fat, ash and crude fiber contents were determined according to Carbohydrate content was calculated by difference **A.O.A.C.(1995)**. **(Menezes *et al*., 2004)**.

Caloric values

Caloric values of beet root powder and beef kofta were calculated according to **Lawrence, (1965)**.

Caloric value (K.cal/100 g) = (protein content x4)+ (carbohydrate content x4) + (fat content x 9).

Sensory evaluation of beef kofta

Sensory evaluation of beef kofta was carried out with 20 panelists comprising of food stuff and postgraduate students from Faculty of Specific Education, Kafrelsheikh University. Testing was done in the Nutrition and Food Science Laboratory. Each panelist was served with 4 randomly arranged beef kofta samples on a rectangular plastic tray. The 4 samples consisted of 3 types of substituted beef kofta and control. Water was provided for rinsing between the samples. Panelists were required to evaluate appearance, taste, flavor, color, texture and acceptance of beef kofta using a 10- point hedonic scale (**Ihekoronye and Ngoddy,1985)**.

Physical evaluation of beef kofta

Beef kofta was weighted in grams before and after cooking as described by method of **A.A.C.C. (2000)**.Cooking loss was calculated by difference. Length of beef kofta were measured to the nearest (cm) according to **A.A.C.C. (1983).**

Statistical analysis

The mean and the standard deviation were calculated. The obtained data were subjected to analysis of variance one-way. The mean value of treatments was compared according to Duncan's multiple range tests. The data were analyzed using SPSS (version 28) according to **(Steel and Torrie ,1980)**.

Results and Discussion:

Chemical composition of beet root powder

Table (1) showed chemical composition of beet root powder. Results indicated that beet root powder contained (6.77±0.01, 11.30±0.15 , 0.55±0.02, 3.65±0.01, 19.88±0.02 and 57.85±0.15 g/100g), respectively for moisture, protein, fat, ash, fibers and carbohydrates. Caloric value recorded (281.55±0.01k.cal / 100g.).

Dhawan and Sharma, (2019) studied the proximate analysis of beetroot flour. They found that beetroot flour contained, moisture 6.30±0.20 , ash 7.89±0.10, fat 1.53±0.15, crude fiber 5.08±0.16, protein 1.61±0.33 and carbohydrate 77.74±1.07(g/100g).

Table (1): Chemical composition of beet root powder

Chemical composition	Beet root powder
Moisture	6.77±0.01
Crude Protein	11.30±0.15
Crude fat	0.55±0.02
Ash	3.65±0.01
Crude fibers	19.88±0.02
Carbohydrates	57.85±0.15
Energy (K.cal/100g)	281.55±0.01

Chemical composition of prepared beef kofta

The modern technology in different fields gives chance for the meat processors to produce new products in different shapes, easily handled, stored and rapidly used .The need for meat products have many tasks includes new flavor and preservation. The quality of raw material as well as the additives used in the final products is very important for public health **(Pearson and Gillette, 1996).**

The proximate chemical composition included moisture, crude protein, crude fat, ash, crude fibers and carbohydrates of prepared beef kofta presented in Table (2) showed that control recorded the highest value of moisture, protein and fat (38.92±0.02, 22.56±0.15 and 8.63±0.15 g/100 g, respectively). Beef kofta with 3% beet root powder recorded the lowest value of moisture, ash and crude fiber (37.20±0.00 g/100g), while beef kofta with10% beet root powder recorded the lowest value had the lowest value of protein and fat (19.25±0.01 and 8.06±0.03 g/100g , respectively).Protein and fat decreased with increasing beet root powder levels, while moisture, ash and fibers increased. It may be due to chemical component in beet root powder (Table.1). Significant differences at $P<0.05$ were found between treated samples for moisture, fat , ash , fibers and carbohydrates compared with control. The exceptional composition of beetroot (high content of vitamins, antioxidants, and other biologically active compounds), their consumption, and/or their application as functional ingredient in meat products can exert important health-promoting properties (**De Oliveira *et al.*, 2020**). The direct use of beetroot juice or powder can have a negative effect on the sensory characteristics of meat

products. This is due to the presence of geosmin in the beetroot, which impart a significant and undesirable earthy flavor (**Kumar and Brooks, 2018**).

Table (2) : Chemical composition of prepared beef kofta as (g/100g).

Samples	Moisture	Crude Protein	Crude fat	Ash	Crude fibers	Carbohydrates
Control	38.92±0.02 a	22.56±0.15 a	8.63±0.15 a	2.20±0.02 d	1.31±0.01 d	26.38±0.27 d
Beef kofta with 3% beet root powder	37.20±0.00 d	20.01±0.01 b	8.27±0.01 b	2.25±0.01 c	1.60±0.12 c	30.67±0.03 a
Beef kofta with 5% beet root powder	37.41±0.02 c	19.91±0.01 b	8.15±0.01 c	2.33±0.02 b	1.88±0.02 b	30.32±0.03 b
Beef kofta with 10% beet root powder	37.76±0.15 b	19.25±0.01 c	8.06±0.03 d	2.42±0.02 a	2.37±0.01 a	30.14±0.17 c

Mean values in the same column which are not followed by the same letter indicate significant difference at P<0.05.

Caloric values of prepared beef kofta

Data in Table (3) presented the caloric values of prepared beef kofta. Carbohydrates represented the main source of calories in prepared beef kofta. Control recorded the highest value of protein and fat calories (90.24 ±0.10 and 77.67±0.10 k.cal./100g), beef kofta with 3% beet root powder recorded the highest value of carbohydrates calories (122.68±0.10k.cal./100g), respectively. Significant differences at P<0.05were found between samples for protein , fat , carbohydrates calories .The highest total caloric value were found in beef kofta with 3% beet root powder (277.15±0.15 k.cal./100 g) was, followed by beef kofta prepared with 5% beet root powder (274.27±0.10 k.cal./100 g).The lowest caloric values found in beef kofta with 10% beet root powder (270.10±0.20 k.cal./100 g) . Significant differences at P<0.05 were found between samples.

Table (3): Caloric values of prepared beef kofta

Sample	Sources of calories			Total caloric values
	Protein	Fat	Carbohydrates	
Control	90.24±0.10 a	77.67±0.10 a	105.52±0.20 d	273.43±0.10 c
Beef kofta with 3% beet root powder	80.04±0.15 b	74.43±0.20 b	122.68±0.10 a	277.15±0.15 a
Beef kofta with 5% beet root powder	79.64±0.20 c	73.35±0.15 c	121.28±0.15 b	274.27±0.10 b
Beef kofta with 10% beet root powder	77.00±0.15 d	72.54±0.10 d	120.56±0.20 c	270.10±0.20 d

Mean values in the same column which are not followed by the same letter indicate significant difference at P<0.05.

Sensory evaluation of beef kofta

Consumers have become more selective and more considered about the quality of the product, which became a more significant factor in marketing meat products **(Eman, 2009)**. Data in Table (4) cleared the sensory evaluation of prepared beef kofta .For appearance, it was noticed that control and beef kofta prepared using 3%beet root powder recorded the highest value (9.90±0.31 and 10.00±0.00, respectively). Significant differences at P<0.05were found between beef kofta prepared using 5,10% beet root powder compared with control. For taste, it was noticed that control and beef kofta prepared using 3%beet root powder recorded the highest value (9.60±0.51, 9.40±0.51, respectively). Significant differences at P<0.05were found between beef kofta prepared using 5,10% beet root powder and control. For flavor, it was noticed that control and beef kofta prepared using 10%beet root powder recorded the same value (10.00±0.00). Non- significant differences at P<0.05were found between beef kofta prepared using 5,10% beet root powder and control . Desirable flavor may be due to the flavor of beet root powder. Color is a vital quality attribute of food and plays an important role in sensory and consumer acceptance of products **(Sowbhagya *et al*.,2005)**. Nowadays, food producers pay more attention towards colors and additives of natural origin, since many artificial colors and additives have been shown to impart negative health effects. Red beetroot contains a high percentage of betalains, which can serve as naturally beneficial antioxidants and natural

colors instead of industrial chemical colors. It was noticed that control and beef kofta prepared using 3%beet root powder recorded the highest color value (9.50±0.52 and 9.10±0.31, respectively). Significant differences at P<0.05were found between beef kofta prepared using 5,10% beet root powder and control. Non- significant differences at P<0.05were found between beef kofta prepared using 3 and 5% beet root powder. Texture scores decreased with increasing beet root powder percent , it may due to increasing in fibers content for treated samples Table (2). Control and beef kofta prepared using 3% beet root powder recorded the highest value (9.20±0.78 and 9.00±0.00, respectively). Non-significant differences at P<0.05were found between treated samples compared with control. All prepared beef kofta were accepted. Non-significant differences at P<0.05were found between beef kofta prepared using 3% beet root powder compared with control, also non- significant differences at P<0.05were found between beef kofta prepared using 5,10% beet root powder. It was recorded (10.00±0.00, 10.00±0.00, 8.80±0.42 and 8.90±0.31, respectively) for control and beef kofta prepared with 3,5 and 10% beet root powder. **Dincer *et al*., (2021)** found that the use of beetroot extract and powder positively affected sensory appearance, color, flavor and overall acceptance of the sausages. The incorporation of beetroot extract improved color, flavor and appearance scores. The incorporation of fermented beetroot extract in meat emulsion systems improved color and odor scores in comparison with control samples formulated without synthetic nitrite, which resulted in higher overall acceptability scores than samples formulated without synthetic nitrite **(Choi *et al*., 2017)**.

Swastike *et al*.,(2020) who reported that chicken sausages reformulated with beetroot powder resulted in a higher color (due to the highest red color) and lower flavor scores (due to the earthy taste of beetroot powder) than control samples, while the inclusion of beetroot powder did not affect the overall acceptability .The flavor scores of sausage were significantly improved (P<0.05) by the addition of beetroot powder. No significant difference (P<0.05) could be established in odor and texture scores of raw sausage as a result of the addition of beetroot to sausage formulation **(Ghazy *et al*.,2020)**.

Table (4): Sensory evaluation of beef kofta

Samples / Sensory characteristics	Control	Beef kofta with 3% beet root powder	Beef kofta with 5% beet root powder	Beef kofta with 10% beet root powder
Appearance	9.90±0.31a	10.00±0.00a	9.20±0.42 b	8.80±0.42 c
Taste	9.60±0.51 a	9.40±0.51 ab	9.00±0.47 bc	8.90±0.31 c
Flavor	10.00±0.00 a	9.20±0.42 b	9.90±0.31 a	10.00±0.00 a
Color	9.50±0.52 a	9.10±0.31 b	8.80±0.42 bc	8.50±0.52 d
Texture	9.20±0.78 a	9.00±0.00 a	8.90±0.42 a	8.80±0.42 a
Acceptance	10.00±0.00 a	10.00±0.00 a	8.80±0.42 b	8.90±0.31 b

Mean values in the same row which are not followed by the same letter indicate significant difference at P<0.05.

Physical properties of beef kofta

Data in Table (5) cleared the physical properties of prepared beef kofta. Control recorded the lowest value of weight before cooking (60.16±0.15g), while beef kofta prepared using 10% beet root powder recorded the highest value (67.20±0.20g), Significant differences at P<0.05 were found between treated samples compared with control. For weight after cooking , control recorded the lowest value (43.16±0.15 g), beef kofta prepared using 10% beet root powder recorded the highest value (52.10±0.15 g), significant differences at P<0.05 were found between treated samples compared with control. Cooking loss decreased by using beet root powder as control recorded the highest cooking loss value (17.00±0.00 g), while beef kofta prepared using 10% beet root powder recorded the lowest cooking loss value (15.10±0.00g). Significant differences at P<0.05 were found between treated samples compared with control. For length, control recorded the lowest value (3.60±0.10 cm), beef kofta prepared using 10% beet root powder recorded the highest value (4.10±0.10cm). Significant differences at P<0.05 were found between beef kofta prepared using 10% beet root powder and control, non significant differences at P<0.05 were found between beef prepared using 3and 5 % beet root powder. The cooking loss in beef kofta is expected during processing, since the water is evaporated during drying according to relative humidity conditions **(Puolanne and Petaja, 2014)**.

Table (5): Physical properties of beef kofta

Physical properties / Beef kofta	Weight before cooking g	Weight after cooking g	Cooking loss g	Length cm
Control	60.16±0.15 d	43.16±0.15 d	17.00±0.00 a	3.60±0.10 c
Beef kofta with 3% beet root powder	63.10±0.10 c	47.10±0.10 c	16.00±0.00 b	3.80±0.10 bc
Beef kofta with 5% beet root powder	65.10±0.10 b	49.25±0.10 b	15.85±0.00 c	4.00±0.10 ab
Beef kofta with 10% beet root powder	67.20±0.20 a	52.10±0.15 a	15.10±0.00 c	4.10±0.10 a

Mean values in the same column which are not followed by the same letter indicate significant difference at P<0.05.

Conclusion

Beetroot is a super food used as therapeutic and functional food ingredient from ancient times. . It has various applications as a food coloring ingredient in many dairy and food products. In conclusion, beet root powder can be partially substituted meat in production of beef kofta to change the bad fast food concept and proved ash, fibers and carbohydrates. All treated samples were accepted. Physical properties of beef kofta improved by using beet root powder.

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