Effect of refrigerated storage on the quality characteristics of microwave cooked chicken *seekh kababs* extended with different non-meat proteins

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Abstract Storage quality of chicken *seekh kababs* extended with different legumes at optimum level viz. 15% cowpea, 15% green gram and 10% black bean were assessed in terms of physico-chemical, proximate, microbiological and sensory properties under aerobic packaging conditions at refrigeration temperature ($4\pm1^{\circ}\text{C}$). The chicken *seekh kababs* were prepared from spent hens meat by low power microwave method and extended with optimum level of different legume (hydrated 1:1 w/w) pastes replacing lean meat in the formulation. The chicken *seekh kababs* formulated without any extender served as control and were compared with extended chicken *seekh kababs*. The *kababs* were aerobically packaged in low density polyethylene (LDPE) pouches and were analyzed at a regular interval of 0, 7, 14 and 21 days during refrigerated storage at $4\pm1^{\circ}\text{C}$. The results indicated a significant ($p<0.05$) decrease in moisture content of the *kababs* whereas the fat and ash content increased significantly ($p<0.05$) over the period of storage. Protein

percentage showed a non-significant ($p>0.05$) increase and almost all the sensory attributes showed a declining trend with advancement of storage. Total plate count and psychrophillic count also increased significantly ($p<0.05$) whereas coliforms were not detected throughout the period of storage. The products were acceptable throughout the storage period.

Keywords *Seekh kabab* · Spent hen meat · Non-meat proteins · Low power microwave · Refrigerated storage

Introduction

Kababs are one of the popular convenience ready to eat meat products and are available in food outlets world wide. These are usually prepared from lamb and beef, though particular styles of *kabab* can be made from meat of other animals like chicken, fish etc. Among the different *kababs*, *seekh kababs* are most popular but the costs of these products are high to be affordable to all the sections of society. Thus its economic formulation keeping the sensory attributes to acceptable limit is a challenge and as such there is a great need of some low cost meats and lean meat replacers. Further the cost of meat and meat products is quite high in comparison to many vegetable products. Thus the addition of low cost vegetable origin extenders to stretch the availability of *seekh kababs* is an important research area.

The increased concern for nutritional security of common mass demands a holistic approach to stretch the availability of quality protein sources by reducing the cost of formulated products. The ICMR recommendation for protein consumption of 1 g/kg body wt/day with Net Protein Utilization (NPU) of 65 could be achieved only by introducing the animal proteins in regular diet. Poultry

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industry, a vibrant, organized and scientific sector now days, can play a key role in ensuring quality animal proteins at cheaper rate particularly through culled and spent hen meat. Processing of meat from spent hen to different value added products open the avenues for not only its judicious utilization but a readily accessible animal protein sources for poor. Emphasis over food processing and economic formulation has made it necessary to do the needful work in this direction.

Spent hens are old and culled chickens, which have completed their productive and reproductive phase of life and are considered as byproduct of egg industry (Mahapatra 1992). Their meat is considered poor because of higher toughness and less juiciness which are due to high collagen content (Abe et al. 1996) and high degrees of cross linkages (Wenham et al. 1973; Bailey 1984) as compared to broiler meat. Problem of poor utilization can be resolved by development of further processed convenience products (Kondaiah 1990; Choudhury et al. 1992) such as sausages, patties, *kababs*, rolls, steaks, nuggets, blocks etc.

Furthermore the raising cost of broiler and mutton in India coupled with requirement to develop traditionally versatile and easily prepared meat items have created a need for alternatives. Thus prospects of further developing certain low cost meat products like *seekh kababs* by extending with certain low cost non-meat protein extenders (like legumes) could find increasing popularity in food service industry particularly at fast food outlets.

A number of legumes (non-meat proteins) have been used as binders and extenders in comminuted meat products. They are rich in proteins and are generally good sources of slow releasing carbohydrates. Stability, yield, textural palatability, and cost of meat products are the major criteria for non-meat proteins (Roberts 1974). Inclusion of legumes in daily diet has many physiological effects in controlling and preventing various metabolic diseases such as coronary heart disease, and colon cancer (Tharanathan and Mahadevamma 2003). Legumes provide energy, dietary fibre, proteins, minerals and vitamins required for human health. But a very few workers have attempted the still inconclusive studies on the legumes as extenders in *seekh-kababs*. Thus, the present study was envisaged to evaluate the effects of refrigerated storage on the quality characteristics of chicken *seekh kababs* extended with different non-meat proteins at their optimum levels.

Materials and methods

Chicken meat

Vanaraja birds (irrespective of sex) of the age group of over 80 weeks were purchased from State Animal Husbandry

Department. The birds were slaughtered using ritual Halal method. The body fat was trimmed and deboning of dressed chicken was done manually removing all tendons and separable connective tissue. The lean meat was packed in polythene bags and frozen at -20°C until use.

Condiments

Onion, garlic and ginger in the ratio of 3:2:1 were ground in a mixer to the consistency of fine paste.

Refined wheat flour

It was purchased from local market and used.

Non meat proteins/ legumes

Cowpea (*Vigna unguiculata*), also known as black-eye bean/pea or cow gram, is one of the most ancient human food sources. Green gram, also known as mung bean, mash bean or green soy, is the seed of *Vigna radiata* (previously called *Phaseolus aureus* or *Phaseolus radiatus*) which is native to India. Black bean (*Vigna mungo*), also referred to as urad dal or bean, black matpe bean, black lentil, or white lentil, is a bean grown in Southern Asia.

Preliminary trials were conducted to determine the optimum levels of the different extenders and *seekh kababs* were prepared with different extenders at those optimum levels viz. cowpea at 15%, green gram at 15% and black bean at 10% level.

The legumes were obtained from local market and converted to paste form after overnight soaking (1:1 w/w hydration) and were incorporated at 15% (cowpea), 15% (green gram) and 10% (black bean) level in the formulation replacing lean meat.

Fat

Refined cottonseed oil of brand name 'Ginni' (Amrit Banaspati Co. Ltd., Fatehpuri, Delhi-06) was purchased from local market and used.

Spice mixture

The spice mix formula used by Kumar and Sharma (2005) was followed and contained aniseed (12%), bay leaves (2%), black pepper (12%), cardamom (5%), cinamom (5%), cloves (2%), colored chilli (1%), coriander (20%), cumin seed (15%), mace (2%), nutmeg (2%), red chilli (12%) and thymol (10%).

The spices were purchased from local market. After removal of extraneous matter, all spices were dried in an oven at 50°C for overnight and then ground in grinder to

powder. The coarse particles were removed using a sieve (100 mesh) and the fine powdered spices were mixed in required proportion to obtain spice mixture for chicken *kababs*. The spice mixture was stored in plastic airtight container for subsequent use.

Methodology of preparation of *seekh-kababs* from meat of spent hen

Lean meat from spent hen was cut into smaller chunks and minced in a Sirman mincer (MOD-TC 32 R10 U.P. INOX, Marsango, Italy) with 6 mm plate followed by common grind size, the 4 mm plate. The common salt, vegetable oil, refined wheat flour (maida), nitrite, sodium tripolyphosphate, spice mixture and condiment mixture were added to weighed meat according to formulation. Meat emulsion for chicken *kababs* was prepared in Sirman Bowl Chopper [MOD C 15 2.8 G 4.0 HP, Marsango, Italy]. Minced meat was blended with salt, sodium tripolyphosphate and sodium nitrite for 1.5 min. Water in the form of crushed ice was added and blending continued for 1 min. This was followed by addition of refined vegetable oil and blended for another 1 to 2 min. This was followed by addition of spice mixture, condiments and other ingredients and again mixed for 1.5 to 2 min to get the desired emulsion.

The various ingredient used in the formulation of the chicken *seekh-kababs* were lean meat (67.7%), added water (10%), vegetable oil (9%), condiment mixture (5%), refined wheat flour (4%), spice mixture (2%), table salt (1.5%), monosodium glutamate (0.5%), sodium tripolyphosphate (0.3%) and sodium nitrite (120 ppm).

Moulding of *kababs*

Kababs were moulded on glass skewers. The skewers of 10 mm diameter and of length sufficient to fit in the microwave were used and typically, the glass skewer was a round rod with one end pointed and the other blunt. The skewers were held in position with the help of two glass stands aligned in the microwave.

Holding the skewer in one hand, an accurately weighed quantity (60 g) of meat mix/emulsion, in the form of a ball, was taken in the other hand, pierced through the pointed end and pressed on to middle of the skewer. With the help of moistened palm and fingers, it was gently spread evenly and moulded into a cigar shaped *kabab*. The length of the *kabab* was determined and averaged 18 cm.

Cooking of *kababs*

The moulded raw *kababs* were smeared with vegetable oil and cooked in an IFB microwave (Model-30SC1) adjusted to low power microwave for a total time of about 14 min.

The internal temperature of *kababs* was monitored by a thermometer and cooked to an internal temperature of $78 \pm 2^\circ\text{C}$. The *kababs* were removed from the skewers, cooled to room temperature (25°C approximately) and individually weighed. Pooled sample of each treatment was assigned for analysis.

Analytical procedures

The pH of cooked *seekh kababs* was determined by the method of Keller et al. (1974) with slight modifications using a digital meter (Systronics Digital pH Meter 803, serial No. 603). Proximate composition viz. moisture, fat, ash and crude protein content of cooked chicken *seekh kababs* was determined by standard methods described by AOAC (1995).

Thiobarbituric acid reacting substances (TBARS) value of *seekh kababs*, during storage was determined using the method of Witte et al. (1970). Free fatty acid value of *seekh kababs* was determined by the methods described by Koniecko (1979).

Total plate count, Psychrophillic count and Coliform count in the samples were determined by methods described by APHA (1984). Readymade media (Hi-Media) were used for the analysis.

Sensory evaluation

The sensory evaluation of the product was carried for attributes, namely appearance, flavour, juiciness, texture and overall palatability by a panel of trained members composed of scientists and research scholars of the Division based on a 8-point hedonic scale, wherein 8 denoted “extremely desirable” and 1 denoted “extremely undesirable” (Seman et al. 1987). The panels were trained for four basic tests, i.e., recognition and threshold test and hedonic tests routinely performed in sensory evaluation laboratory of the Division. Panelists were seated in a room free of noise and odours and suitably illuminated. Coded samples for sensory evaluation were prepared and served warm to panelists at 40°C . Water was provided for oral rinsing between the samples.

Statistical analysis

Experiment was replicated six times and means and standard errors were calculated for different parameters. The data obtained were subjected to statistical analysis (Snedecor and Cochran 1980) for analysis of variance, critical difference and Duncan’s multiple range tests for comparing the means to find the effects between treatments and storage periods for various parameters. The software package SPSS-12 was used for statistical analysis.

Results and discussion

Physico-chemical characters

The mean values of various physico-chemical characters of aerobically packaged microwave cooked chicken *seekh kababs* extended with different non-meat protein pastes (hydrated 1:1 w/w) as well as control are presented in Table 1.

pH

In the present study, selected non-meat proteins (treatments) had a significant ($P<0.05$) effect on the pH values in all treated samples. The effect of storage was obvious as the pH of chicken *kababs* followed an increasing trend at progressive storage intervals. There was a significant ($P<0.05$) increase in pH of most of treated groups. The mean pH values of extended products with different treatments were comparable to each other on day 0 and 7 of storage whereas the mean pH value of control varied significantly with all the treatments on day 0 and 7 of storage. The mean pH values of extended products with different treatments were comparable to each other on day 14 and 21 of storage whereas the mean pH value of control varied significantly ($P<0.05$) with all the treatments except black bean treatment on day 14 and 21 of the storage. The increase in pH might be due to accumulation of metabolites of bacterial action on meat and meat products and deamination of meat proteins (Bachhil 1982; Jay 1986). Nag et al. (1998) also observed a gradual increase in pH of LDPE packed extended chicken nuggets stored at $4\pm1^\circ\text{C}$. Further

Sunki et al. (1978), Murthy and Bachil (1980), Prabhakara and Narhari (1990) and Prabhakara and Satyanarayana (1990) have also reported a progressive increase in pH of refrigerated stored meat products.

Free fatty acid (FFA)

FFA value followed a significant ($P<0.05$) linear increasing trend from day 0 to 21 in extended products as well as control. A difference among the treatments also existed on day 14 and 21 of storage. *Kababs* extended with different non-meat proteins as well as control had comparable FFA values with each other on day 0 and 7 of storage except for black bean extended *kababs* which varied significantly ($P<0.05$) with control on day 0 of storage. Similar trend was observed by Anand et al. (1991), Nayak and Tanwar (2004) and Nagamallika et al. (2006) in chicken patties during refrigerated storage.

Thiobarbituric acid reacting substances (TBARS) value

Thiobarbituric acid reacting substances (TBARS) value showed a significant ($P<0.05$) linear increasing trend from day 0 to 21 in case of black gram extended products as well as control whereas cowpea and green gram extended products had comparable values on day 0 and 7 of storage and there after followed a significant ($P<0.05$) linear increasing trend from day 7 to 21 of storage. A difference among the treatments also existed as the TBARS value of black bean extended *kababs* varied significantly ($P<0.05$) with other treatments. The increase in TBARS values on storage might be attributed to oxygen permeability of

Table 1 Effect of refrigerated storage on physico-chemical characteristics of aerobically packaged microwave cooked chicken *seekh kababs* extended with different non- meat proteins. (Mean $\pm$ SE)

Mean $\pm$ SE with different superscripts in a row wise (upper case alphabet) and column wise (lower case alphabet) differ significantly ($P<0.05$), n_1 (pH)=3, n_2 (TBA and FFA)=6 for each treatment
C = Control, CP = Cowpea, GG = Green gram, BB = Black bean

Treatments	Storage period (days)			
	0	7	14	21
pH				
C	6.1 $\pm$ 0.02 ^{Aa}	6.2 $\pm$ 0.03 ^{ABa}	6.3 $\pm$ 0.03 ^{BCa}	6.3 $\pm$ 0.06 ^{Ca}
CP (15%)	6.2 $\pm$ 0.03 ^{Ab}	6.3 $\pm$ 0.02 ^{Ab}	6.3 $\pm$ 0.01 ^{Bb}	6.4 $\pm$ 0.01 ^{Bb}
GG (15%)	6.3 $\pm$ 0.02 ^{Ab}	6.3 $\pm$ 0.02 ^{Ab}	6.3 $\pm$ 0.01 ^{Bb}	6.4 $\pm$ 0.02 ^{Cb}
BB (10%)	6.2 $\pm$ 0.01 ^{Ab}	6.3 $\pm$ 0.01 ^{Bb}	6.3 $\pm$ 0.01 ^{Bab}	6.4 $\pm$ 0.01 ^{Cab}
FFA (% oleic acid)				
C	0.0020 $\pm$ 0.00 ^{Aa}	0.015 $\pm$ 0.001 ^{Ba}	0.025 $\pm$ 0.00 ^{Ca}	0.047 $\pm$ 0.001 ^{Da}
CP (15%)	0.0022 $\pm$ 0.00 ^{Aab}	0.014 $\pm$ 0.001 ^{Ba}	0.022 $\pm$ 0.001 ^{Cb}	0.043 $\pm$ 0.001 ^{Db}
GG (15%)	0.0021 $\pm$ 0.00 ^{Aab}	0.013 $\pm$ 0.001 ^{Ba}	0.021 $\pm$ 0.001 ^{Cb}	0.042 $\pm$ 0.001 ^{Db}
BB (10%)	0.0023 $\pm$ 0.00 ^{Ab}	0.015 $\pm$ 0.001 ^{Ba}	0.025 $\pm$ 0.001 ^{Ca}	0.046 $\pm$ 0.001 ^{Da}
TBARS (mg malonaldehyde/kg)				
C	0.27 $\pm$ 0.017 ^{Aa}	0.41 $\pm$ 0.015 ^{Ba}	0.56 $\pm$ 0.019 ^{Ca}	0.67 $\pm$ 0.028 ^{Da}
CP (15%)	0.30 $\pm$ 0.018 ^{Aa}	0.34 $\pm$ 0.009 ^{Ab}	0.47 $\pm$ 0.018 ^{Bb}	0.58 $\pm$ 0.020 ^{Cb}
GG (15%)	0.28 $\pm$ 0.011 ^{Aa}	0.32 $\pm$ 0.009 ^{Ab}	0.46 $\pm$ 0.022 ^{Bb}	0.57 $\pm$ 0.026 ^{Cb}
BB (10%)	0.30 $\pm$ 0.017 ^{Aa}	0.42 $\pm$ 0.014 ^{Ba}	0.57 $\pm$ 0.020 ^{Ca}	0.68 $\pm$ 0.026 ^{Da}

packaging material (Brewer et al. 1992) that led to lipid oxidation. Salahuddin et al. (1989), Prabhakara and Vijayalakshmi (1998), Prabhakara and Satyanarayana (1990), Prabhakara and Eswara (1997), Dushyanthan et al. (2000) and Kumar (2001) have also reported an increase in TBARS values with increasing storage period. A comparatively slow increase in TBARS value of *kababs* extended with 15% cowpea and green gram might be due to lower fat percent and increased fiber content which acted as antioxidant. Bertelsen et al. (1991) also reported about the natural antioxidant nature of pea fiber.

Proximate-composition

Mean proximate values of aerobically packaged chicken *seekh kababs* extended with optimum level of non meat proteins as well as control during storage at $4\pm1^\circ\text{C}$ are presented in Table 2.

Moisture

The mean moisture values of extended products with different treatments as well as control on day 0 were comparable to mean moisture values on day 7 whereas the mean moisture values of extended products with different treatments as well as control on day 7, 14 and 21 were comparable. The moisture values of extended products with different treatments as well

as control were comparable to each other on day 0 whereas the mean moisture values of control on day 7, 14 and 21 differed significantly ($P<0.05$) with all treatments except with black bean extended *seekh kababs*. Rao and Reddy (2000) and Sharma and Rao (1996) have also reported a decrease in moisture values with increasing storage period.

Protein

The mean protein values of extended products with different treatments as well as control were comparable to each other on all days of storage. The values showed a non-significant ($P>0.05$) increasing trend throughout the period of storage. It may be attributed to the increasing dry matter content with storage. Rao and Reddy (2000) and Sharma and Rao (1996) have also reported an increase in protein values with increasing storage period.

Fat

The mean fat values of extended products with different treatments as well as control on day 0 were comparable to mean fat values on day 7 whereas the mean fat values of extended products with different treatments as well as control on day 7, 14 and 21 were comparable. Overall, there was a significant ($p<0.05$) increasing trend in the mean fat values of extended products as well as control except for black bean

Table 2 Effect of refrigerated storage on proximate composition of aerobically packaged microwave cooked chicken *seekh kababs* extended with different non-meat proteins. (Mean $\pm$ SE)

Treatments	Storage period (days)			
	0	7	14	21
Moisture (%)				
C	59.2 $\pm$ 0.54 ^{Aa}	58.1 $\pm$ 0.71 ^{ABa}	57.2 $\pm$ 0.76 ^{ABa}	56.7 $\pm$ 0.59 ^{Ba}
CP (15%)	57.8 $\pm$ 0.46 ^{Aa}	56.6 $\pm$ 0.60 ^{ABab}	55.7 $\pm$ 0.73 ^{Bab}	55.1 $\pm$ 0.70 ^{Bab}
GG (15%)	57.3 $\pm$ 0.94 ^{Aa}	55.9 $\pm$ 0.55 ^{ABb}	55.2 $\pm$ 0.35 ^{Bb}	54.6 $\pm$ 0.55 ^{Bb}
BB (10%)	57.9 $\pm$ 0.55 ^{Aa}	56.7 $\pm$ 0.55 ^{ABab}	55.9 $\pm$ 0.67 ^{Bab}	55.3 $\pm$ 0.70 ^{Bab}
Protein (%)				
C	18.7 $\pm$ 0.37	19.1 $\pm$ 0.47	19.4 $\pm$ 0.38	19.6 $\pm$ 0.30
CP (15%)	17.5 $\pm$ 0.25	18.1 $\pm$ 0.50	18.3 $\pm$ 0.58	18.6 $\pm$ 0.59
GG (15%)	17.6 $\pm$ 0.39	18.2 $\pm$ 0.43	18.6 $\pm$ 0.40	18.9 $\pm$ 0.34
BB (10%)	18.7 $\pm$ 0.60	19.1 $\pm$ 0.76	19.5 $\pm$ 0.55	19.7 $\pm$ 0.49
Fat (%)				
C	14.6 $\pm$ 0.15 ^{Aa}	15.1 $\pm$ 0.31 ^{ABa}	15.5 $\pm$ 0.34 ^{ABa}	15.7 $\pm$ 0.42 ^B
CP (15%)	13.8 $\pm$ 0.12 ^{Ab}	14.3 $\pm$ 0.15 ^{ABab}	14.6 $\pm$ 0.21 ^{Bab}	14.9 $\pm$ 0.31 ^B
GG (15%)	13.6 $\pm$ 0.25 ^{Ab}	14.1 $\pm$ 0.34 ^{ABb}	14.4 $\pm$ 0.34 ^{ABb}	14.7 $\pm$ 0.40 ^B
BB (10%)	14.1 $\pm$ 0.50 ^{ab}	14.6 $\pm$ 0.33 ^{ab}	14.9 $\pm$ 0.32 ^{ab}	15.2 $\pm$ 0.35
Ash (%)				
C	2.3 $\pm$ 0.05 ^{Aa}	2.5 $\pm$ 0.10 ^{ABa}	2.7 $\pm$ 0.25 ^{AB}	2.8 $\pm$ 0.10 ^B
CP (15%)	2.8 $\pm$ 0.03 ^b	3.0 $\pm$ 0.17 ^b	3.1 $\pm$ 0.18	3.2 $\pm$ 0.10
GG (15%)	2.9 $\pm$ 0.05 ^b	3.0 $\pm$ 0.19 ^b	3.1 $\pm$ 0.25	3.2 $\pm$ 0.13
BB (10%)	2.7 $\pm$ 0.05 ^c	2.8 $\pm$ 0.08 ^{ab}	2.9 $\pm$ 0.08	3.0 $\pm$ 0.20

Mean $\pm$ SE with different superscripts in a row wise (upper case alphabet) and column wise (lower case) differ significantly ($P<0.05$), $n=6$ for each treatment

C = Control, CP = Cowpea, GG = Green gram, BB = Black bean

during the period of storage. It may be attributed to the increasing dry matter content with storage. Rao and Reddy (2000) and Sharma and Rao (1996) have also reported an increase in fat values with increasing storage period.

Ash

The mean ash values of extended products with different treatments were comparable on all storage days except for control on day 0 which differed significantly ($P<0.05$) from the mean ash value for control on day 21. The mean value of ash for control on day 0 differed significantly ($P<0.05$) with all the treatment means on day 0. The mean ash value for control on day 7 varied significantly ($P<0.05$) with all treatments except for black bean extended *kababs* on the same day, whereas the mean ash values on day 14 and 21 were comparable to each other.

Microbiological characters

The mean values of various microbiological characteristics of aerobically packaged microwave cooked chicken *seekh kababs* extended with optimum levels of different non-meat proteins and control are presented in Table 3.

Total plate count (log cfu/g)

Total plate count followed a significant ($P<0.05$) linear increasing trend from day 0 to day 21 in extended products

Table 3 Effect of refrigerated storage on microbiological characteristics (log cfu/g) of aerobically packaged microwave cooked chicken *seekh kababs* extended with different non-meat proteins. (Mean $\pm$ SE)

Treatments	Storage period (days)			
	0	7	14	21
Total plate count (log cfu/g)				
C	1.4 $\pm$ 0.09 ^{Aa}	1.9 $\pm$ 0.04 ^{Ba}	2.4 $\pm$ 0.08 ^{Ca}	2.9 $\pm$ 0.08 ^{Da}
CP (15%)	1.6 $\pm$ 0.07 ^{Aab}	2.0 $\pm$ 0.04 ^{Bb}	2.5 $\pm$ 0.02 ^{Cb}	3.1 $\pm$ 0.08 ^{Db}
GG (15%)	1.5 $\pm$ 0.03 ^{Aab}	2.0 $\pm$ 0.04 ^{Bb}	2.5 $\pm$ 0.02 ^{Cb}	3.1 $\pm$ 0.08 ^{Db}
BB (10%)	1.7 $\pm$ 0.03 ^{Ab}	2.1 $\pm$ 0.02 ^{Bc}	2.6 $\pm$ 0.02 ^{Cc}	3.3 $\pm$ 0.08 ^{Dc}
Psychrophilic count (log cfu/g)				
C	ND	ND	1.2 $\pm$ 0.07 ^A	1.6 $\pm$ 0.05 ^B
CP (15%)	ND	ND	1.4 $\pm$ 0.07 ^A	1.7 $\pm$ 0.05 ^B
GG (15%)	ND	ND	1.4 $\pm$ 0.10 ^A	1.8 $\pm$ 0.05 ^B
BB (10%)	ND	ND	1.4 $\pm$ 0.08 ^A	1.8 $\pm$ 0.08 ^B

Mean $\pm$ SE with different superscripts in a row wise (upper case alphabet) and column wise (lower case) differ significantly ($P<0.05$), $n=6$ for each treatment, Coliforms were not detected throughout storage period

C = Control, CP = Cowpea, GG = Green gram, BB = Black bean, ND = Not detected

and control. A difference among the treatments also existed. Total plate counts of extended *kababs* were higher than control during entire period of storage. *Kababs* extended with different non-meat proteins had comparable counts on day 0. Later on, the counts became significantly ($P<0.05$) higher than control but remained significantly ($P<0.05$) less than the *kababs* extended with 10% black bean paste. Increased extension levels and comparatively low fat percent were associated with higher counts and were in agreement with the results of Draughon (1980) who apprehended the possibility of higher microbial growth in extended foods. Harison et al. (1983) also suggested that one limitation of extended products might be the faster spoilage rate of some extended products. A linear increase in total plate counts of chicken patties stored under refrigeration was also reported by Nath et al. (1995).

Psychrophilic count (log cfu/g)

Psychrophilic counts were not detected on day 0 and 7 of storage in the extended products and control. But, it was observed on day 14 of storage in all treated groups as well as control. The counts for various *kababs*, both extended and control were comparable on day 14 and 21 of storage, although the counts showed a significant ($P<0.05$) increase on day 21 of storage. Although non-significant, the counts for extended *kababs* are higher than control. It might be due to increased possibility of ingress of microbes through extenders. The psychrophilic count always remained well below the maximum permissible limits in cooked meat products (Jay 1986). Cremer and Chipley (1977) described permissible level of psychrophilic count as 4.6 log cfu/g in cooked meat and meat products. A detectable count on day 14 while nil on preceding observations might be attributed to the fact that bacteria generally need some lag phase before active multiplication is initiated. A gradual increase in psychrophilic counts during storage of chicken products had been reported by Sen and Sharma (1996), Nag et al. (1998) and Kalaikanan et al. (2007).

Coliform count (log cfu/g)

The coliforms were not detected throughout the period of storage in both control and extended *kababs*. It could be due to the destruction of these bacteria during cooking at 78°C, much above their death point of 57°C. Further, hygienic practices followed during the preparation and packaging of *kababs* could also be one of the reasons for the absence of coliforms. Dawson et al. (1975) and Kumar and Sharma (2004) also reported zero count of coliform for the product heated to such a high temperature.

Sensory parameters

The mean values of various sensory parameters of aerobically packaged microwave cooked chicken *seekh kababs* extended with different non- meat proteins are presented in Table 4. The sensory attributes were not significantly affected during 21 days of storage, although all the sensory parameters viz., appearance, flavour, juiciness, texture and overall palatability of all treated *kababs* followed a descending trend with increase in storage days. However, the overall palatability score of control *kababs* showed a significant decline on day 21 of storage. The decrease in appearance scores might be due to pigment and lipid oxidation resulting in non-enzymatic browning. A decrease in appearance or colour score of chicken products with increase in storage period

Table 4 Effect of refrigerated storage on sensory attributes of aerobically packaged microwave cooked chicken *seekh kababs* extended with different non-meat proteins. (Mean $\pm$ SE)

Treatments	Storage period (days)			
	0	7	14	21
Appearance				
C	6.9 $\pm$ 0.11	6.9 $\pm$ 0.10	6.8 $\pm$ 0.13	6.6 $\pm$ 0.13
CP (15%)	7.0 $\pm$ 0.12	6.8 $\pm$ 0.13	6.8 $\pm$ 0.13	6.7 $\pm$ 0.13
GG (15%)	6.9 $\pm$ 0.12	6.9 $\pm$ 0.12	6.8 $\pm$ 0.12	6.7 $\pm$ 0.12
BB (10%)	6.9 $\pm$ 0.08	6.8 $\pm$ 0.14	6.8 $\pm$ 0.12	6.6 $\pm$ 0.11
Flavour				
C	6.9 $\pm$ 0.11	6.8 $\pm$ 0.12	6.7 $\pm$ 0.10	6.6 $\pm$ 0.11
CP (15%)	6.9 $\pm$ 0.10	6.8 $\pm$ 0.12	6.7 $\pm$ 0.13	6.6 $\pm$ 0.13
GG (15%)	6.7 $\pm$ 0.10 ^A	6.7 $\pm$ 0.14 ^{AB}	6.4 $\pm$ 0.13 ^{AB}	6.4 $\pm$ 0.11 ^B
BB (10%)	6.7 $\pm$ 0.11	6.6 $\pm$ 0.10	6.4 $\pm$ 0.15	6.3 $\pm$ 0.14
Juiciness				
C	6.9 $\pm$ 0.12	6.9 $\pm$ 0.09	6.8 $\pm$ 0.09	6.7 $\pm$ 0.10
CP (15%)	6.8 $\pm$ 0.09	6.7 $\pm$ 0.09	6.6 $\pm$ 0.11	6.6 $\pm$ 0.11
GG (15%)	6.8 $\pm$ 0.11	6.7 $\pm$ 0.14	6.6 $\pm$ 0.10	6.5 $\pm$ 0.09
BB (10%)	6.7 $\pm$ 0.13	6.6 $\pm$ 0.13	6.5 $\pm$ 0.15	6.4 $\pm$ 0.14
Texture				
C	6.9 $\pm$ 0.10	6.9 $\pm$ 0.11	6.8 $\pm$ 0.09	6.6 $\pm$ 0.11
CP (15%)	6.9 $\pm$ 0.09	6.8 $\pm$ 0.12	6.7 $\pm$ 0.09	6.6 $\pm$ 0.11
GG (15%)	6.8 $\pm$ 0.09	6.8 $\pm$ 0.09	6.7 $\pm$ 0.11	6.5 $\pm$ 0.11
BB (10%)	6.8 $\pm$ 0.09	6.7 $\pm$ 0.09	6.6 $\pm$ 0.12	6.5 $\pm$ 0.12
Overall palatability				
C	6.9 $\pm$ 0.11 ^A	6.8 $\pm$ 0.12 ^{AB}	6.7 $\pm$ 0.09 ^{AB}	6.6 $\pm$ 0.11 ^B
CP (15%)	6.9 $\pm$ 0.15	6.9 $\pm$ 0.09	6.8 $\pm$ 0.09	6.6 $\pm$ 0.11
GG (15%)	6.8 $\pm$ 0.12	6.8 $\pm$ 0.11	6.7 $\pm$ 0.11	6.5 $\pm$ 0.09
BB (10%)	6.8 $\pm$ 0.13	6.7 $\pm$ 0.09	6.6 $\pm$ 0.14	6.5 $\pm$ 0.13

Mean $\pm$ SE with different superscripts in a row (upper case alphabet) and column (lower case) differ significantly ($P < 0.05$), $n = 21$ for each treatment

C = Control, CP = Cowpea, GG = Green gram, BB = Black bean

was also reported by Sen and Sharma (1996), Kalaikannan et al. (2007), Nag et al. (1998) and many others. The progressive decrease in flavour could be correlated to increase in TBARS value of meat product (Tarladgis et al. 1960) stored under aerobic conditions. Nag et al. (1998) and Sharma et al. (1988) also reported a decrease in flavour scores of extended meat product during aerobic storage. Juiciness scores followed a decreasing trend in chicken *kababs* prepared with selected extenders as well as control during the period of storage. It could be due to some loss of moisture from the products during storage. However, the scores were comparable for all treatments throughout the storage. The results were in accordance with findings of Sharma et al. (1988), Nag et al. (1998) and Kaliakannan et al. (2007). Texture scores were comparable in all treated groups and control throughout the storage period. However, a non-significant ($P > 0.05$) gradual decrease was recorded which might be attributed to some dehydration which led to hardening of the texture and also due to breakdown of fat as well as protein. The findings were similar to those of Kumar and Sharma (2004). The overall palatability of chicken *seekh kababs* in all treated groups remained stable throughout the study. A non-significant ($P > 0.05$) decrease in scores during last phase of study might be reflective of the decline in scores of flavour, juiciness and texture attributes. These observations indicated that microwave cooked chicken *seekh kababs* prepared with 15% cowpea, 15% green gram and 10% black bean retained good to very good overall palatability up to day 21 under refrigerated storage at $4 \pm 1^\circ\text{C}$ in low density polyethylene pouches (LDPE).

Conclusion

The present study showed successful utilization of non-meat proteins and spent hen meat in the preparation of *seekh kababs* and the products had almost similar sensory attributes and acceptability as in control *seekh kababs*. Thus chicken *seekh-kababs* of good to very good acceptability and nutritive value could be prepared by extension with non-meat proteins/legumes substituting lean chicken meat from spent hen in formulation by low power microwave method of cooking. The extended chicken *seekh kababs* could be conveniently packed in LDPE for a period of 21 days in refrigerated ($4 \pm 1^\circ\text{C}$) condition without any marked loss of physico-chemical, microbial and sensory quality. Besides ensuring the nutritional security, it will also provide a potential outlet for the poultry industry byproduct (spent hen) and thereby increasing the profit margins of the poultry industry. This study would also help in better use of legume extenders and spent hen meat in other meat products. Further research should be focused on the use of higher amounts and different legumes in *kababs* particularly *seekh-kababs*.

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