Penerbit Akademia Baru

Journal of Advanced Research in Applied Sciences and Engineering Technology

Journal homepage: www.akademiabaru.com/araset.html
ISSN: 2462-1943

Advanced Research in Applied Sciences and Engineering Technology

Open Access

Effects of Fish Collagen Hydrolysate (FCH) as Fat Replacer in the Production of Buffalo Patties

Fakhriyah Nur Ibrahim[1], Mohammad Rashedi Ismail-Fitry[1,*], Masni Mat Yusoff[1], Radhiah Shukri[1]

[1] Department of Food Technology, Faculty of Food Science and Technology, Universiti Putra Malaysia, 43400, Serdang, Selangor, Malaysia

ARTICLE INFO

Article history:
Received 13 February 2018
Received in revised form 4 April 2018
Accepted 6 April 2018
Available online 17 June 2018

ABSTRACT

Pork and bovine collagen incorporated into meat products showed promising functional properties as food ingredients but has the halal issue. This study investigated the effect of incorporating fish collagen hydrolysate (FCH) as a fat replacer in buffalo patties in terms of proximate values, texture and colour properties. There were five different formulations including a control (10% fat, 0% FCH), A (7.5% fat, 2.5% FCH), B (5% fat, 5% FCH), C (2.5% fat, 7.5% FCH), and D (0% fat, 10% FCH). There were no significant differences (p>0.05) between all formulations in terms of cooking yield, shrinkage, water-holding capacity, and pH value. The sensory test showed no significant difference (p>0.05) between all formulations in terms of colour, appearance, juiciness, aroma, and overall acceptability, while sample D with 10% FCH had significantly lower (p<0.05) acceptability in flavour and texture as compared to other formulations. Formulations with higher FCH had higher protein and ash yet lower moisture content. The fat content (w/w) significantly increased (p<0.05) from 3.44% in the control sample to 4.80% in formulation A and 4.49% in formulation B. However, the fat content in formulation C (2.46%) and D (3.11%) were significantly (p<0.05) lower than the control sample. All formulations had no significant difference (p>0.05) in terms of textural properties, except formulation B and formulation C which exhibited significantly (p<0.05) highest (0.39) and lowest (0.17) cohesiveness, respectively. Raw beef patties with higher FCH content were darker as compared to patties with lower FCH content. There were no significant differences (p>0.05) in yellowness and redness of buffalo patties with or without FCH incorporation before and after cooking. In conclusion, FCH has the potential to be used as a fat replacer in the production of low-fat patties.

Keywords:
Buffalo patties, fat replacer, fish collagen hydrolysate, halal collagen

1. Introduction

Fats play a vital role in sensory and structural benefits in food products. Consumer preferences often food that could give the mouthfeel, satiety, satisfaction, full of aroma in which generally contributed by fat in food [12, 18]. In the nutrition standpoint, fat intake contributes to major energy needs of human. However, due to health awareness, consumer nowadays privilege healthier version

* *Corresponding author.*
E-mail address: Mohammad Rashedi Ismail-Fitry (ismailfitry@upm.edu.my)

of food for their consumption. Low-fat food, low sugar food often becomes primary selection amongst educated, urban consumer whom concern about their health risk. The traditional way to replaced fat in food is via water substitution [18]. However, due to technology advancement in food processing, scientist found many carbohydrates, protein-based, synthetic compounds and food additives that can be used as the fat replacer or fat substitutes [12].

Collagen proteins are the most abundant in the human and animal body vital proteins of connective tissue, skin, tendons, cartilage, ligaments, cornea, teeth, nails and hair [2, 10, 11]. The main sources of collagen peptides are bovine hide, bone, pigskin and marine sources [10, 11]. Collagen hydrolysates are processed via hydrolysis until soluble peptide was achieved [10]. In the food industry, many studies have been conducted to study the physicochemical, microbiological and sensory property of meat product incorporated with collagen. As an example, Sousa *et al.*, [24] investigated the use of bovine hydrolysed collagen powder as the fat replacer in frankfurter. Schilling *et al.*, [22] had investigated the use of pork collagen in improving the functionality of sucuk. However, the use of fish hydrolysed collagen as fat replacer has not yet been explored. Due to halal issues of existing collagen derived from bovine (due to slaughtering by non-Muslim) and other non-halal issues revolving around collagen as raw material, fish collagen hydrolysate is seen as a potential field of study in which commonly produced from waste i.e. scales, skin and viscera could solve the issue with beneficial properties.

The demands on the production of low-fat meat products are rising due to awareness of healthy eating habits and health risks associated with inappropriate diets and food consumptions. Using fat substitute to replace fat in meat and low-fat meat product processing has been implemented for decades. Collagen and collagen hydrolysate is a protein-based fat substitute in which has been seen as a potential fat replacer in low-fat beef patties processing. Due to halal issues of collagen and its hydrolysate derived from chicken, bovine and pork, collagen and its derivatives from marine i.e. fish waste seen as alternatives to fat replacer in producing low-fat beef patties. However, the effect of using fish collagen hydrolysate in beef patties need to be further investigated in which to what extent it affects the physicochemical and sensory level of beef patties upon its incorporation. Hence, this study aims to evaluate the physicochemical and sensory characteristics of buffalo patties incorporated with fish collagen hydrolysate as fat replacer.

2. Materials and Methods

2.1 Buffalo Patties Formulation

Table 1
The ingredients used to formulate buffalo patties

Raw materials and ingredients (%)	Control	A	B	C	D
Buffalo Meat	70.00	70.00	70.00	70.00	70.00
Cornstarch	3.50	3.50	3.50	3.50	3.50
Salt	1.20	1.20	1.20	1.20	1.20
Garlic	0.50	0.50	0.50	0.50	0.50
Sugar	1.00	1.00	1.00	1.00	1.00
White pepper	0.50	0.50	0.50	0.50	0.50
Sodium tripolyphosphate (STPP)	0.30	0.30	0.30	0.30	0.30
Buffalo fat	10.00	7.50	5.00	2.50	0.00
Warm water	13.00	13.00	13.00	13.00	13.00
Fish Collagen Hydrolysate (FCH)	0.00	2.50	5.00	7.50	10.00

Control (10% fat, 0% FCH), A (7.5% fat, 2.5% FCH), B (5% fat, 5% FCH), C (2.5% fat, 7.5% FCH) and D (0% fat, 10% FCH).

The meat for the patties was obtained from Pasar Borong Selangor (frozen buffalo topside). The visible fats were initially removed from the meat. The meat and fat were grounded separately in a grinder (standard size hole opening in the grinder plate). After grinding, the meat was divided in 500g and packed frozen at -18°C until further processing and analysis. The ingredients used in the formulation as shown in Table 1 consist of sodium tripolyphosphate (STPP), cornstarch, sugar, salt, white pepper and garlic powder. STPP was purchased from Meilun Sdn Bhd, Klang, Selangor while all other ingredients were purchased from Giant Hypermarket, Serdang, Selangor. The fish collagen hydrolysate (FCH) was obtained from Industri Az-Zahrah Sdn. Bhd., Bangi, Selangor as the sample of in the weight of 700 g in nylon packaging.

2.2 Preparation of Buffalo Patties

The meat and other ingredients were mixed using (Fresh Mixer) for an average of 15 minutes. The corn starched was the first ingredient added was hydrated with warm water at the portion of 1:2. Then, STPP and other ingredients were added simultaneously followed with FCH. Finally, water was added. For individual patties, the meat mixture was weighed manually using patties moulder of 80g each. The 80g portion was pressed into a mould at 10 cm diameter each. After moulding, all samples were kept frozen on a metal tray at -18°C for 24 hours before being packaged into a plastic bag at -18°C until further analysis.

2.3 Physicochemical Analysis
2.3.1 Cooking yield

The buffalo patties were cooked using non-sticky fry pan that was preheated at a cooking temperature of 180-200°C. The patties were cooked until its internal temperature reached 72°C for 3 minutes for each side according to the method from Soncu *et al.*, [23] with some modifications. The weights of the buffalo patties were measured at room temperature before and after cooking. The cooking yield was then reported in percentage as indicated in the formulation below:

$$Cooking\ yield\ (\%) = \ (Cooked\ weight)\ /\ Raw\ Weight) \times\ 100$$

2.3.2 Shrinkage

The diameter (mm) and thickness (mm) of the buffalo patties were measured using vernier calipher. The percentage of shrinkage of the buffalo patties were measured using formulation stated below following methods from Mohammad Nisar *et al.*, [15]:

$$Shrinkage\ (\%) = \ ((w - z) + (y - z))/(w + y)\ \ \times 100$$

where,

w = thickness of raw patties
x = thickness of cooked patties
y = diameter of raw patties
z = diameter of cooked patties

All readings were recorded in triplicate for each triplicate sample.

2.3.3 pH measurements

Five grams in 45 mL of distilled water of raw and cooked patties were homogenized using a mortar and pester manually for one minute. The pH values of the raw and cooked patties were recorded using Jennyway pH meter (Model 3510, Bibbly Scientific Limited) in triplicate for each sample.

2.3.4 Water Holding Capacity (WHC)

The Water Holding Capacity (WHC) determination was adapted from Kohn *et al.*, [13] with some modifications. As preparation, each sample consisted of 5g pre-weighed beef patties homogenized manually at 1 minute in 32 ml distilled water. The sample left at rest for 10 minutes before centrifuged at 25 minutes at 2900 g using centrifuge (Model Juoan G411). The supernatant was then discarded and dried with 10-20^o inclination downwards for 20 minutes at 50^{o}C. The dried sample was then weighed, and reading was recorded. WHC was determined using the calculation as follow:

$$\%\, WHC = ((b-a) - (c-a))/((c-a)) \times 100$$

Where,
a = weight of empty centrifuge
b = weight of centrifuge with supernatant
c = weight of dried centrifuge

2.3.5 Compositional analysis of Fat, Moisture Content, Ash and Protein

The compositional analysis of the cooked buffalo patties was analysed as stated. The fat (ether extractable), ash, protein content and moisture content were determined according to the standard AOAC procedures using a hot air oven, a furnace, a Soxhlet extraction apparatus and a Kjeldahl accordingly [17].

2.3.6 Texture Profile Analysis (TPA)

For Texture Profile Analysis (TPA) of cooked and uncooked beef patties sample, TA-XT2 texture analyser was used with using blade set warner bratzler probe p/75 with compression degree of 75 % with pre-test speed of 1.00 mms-1, test speed of 3.00 mms-1 and post-test speed of 5.00 mms-1 with minor amendments for hardness (N), springiness, cohesiveness and chewiness determinations as indicated by Bourne *et al*., [4].

2.3.7 Colour Measurements

The colour of the raw and cooked samples was measured by using colorimeter (Minolta Chromameter) as stated by Phrabu *et al.,* [19]. The raw sample was thawed at room temperature for 30 minutes to 1 hour before analysis while for the cooked sample, the colour assessment was conducted after 30 min to 1 hour after cooking preparation. The cooked patties were left at room temperature before analysis. The colorimeter was calibrated using white A4 paper with a reading of l (lightness-darkness), a (redness-greenness) and b (yellowness-blueness) of 66.88, 69.94 and 81.22. All readings were taken triplicate for each sample.

2.4 Sensory acceptance test

Sensory acceptance test was carried out by 30 untrained panellists. The panellists were asked to evaluate the patties based on a hedonic scale of 1-5 for colour, flavour, appearance, juiciness, texture and overall acceptability of the cooked beef patties. The hedonic scale was 1- not acceptable 2- fairly acceptable 3- acceptable 4- highly acceptable and 5- extremely acceptable.

2.5 Statistical Analysis

Each parameter was analyzed in triplicate. Data were collected and analyzed by using Minitab® 17 Statistical Software as used by Sousa *et al.*, [24] with some modification. A multifactor analysis of variance (ANOVA) was used to evaluate the effect of collagen at different percentage added on beef patties.

3. Results and Discussion

3.1 Cooking yield and shrinkage percentage

The percentage of cooking yield and shrinkage of the buffalo patties as presented in table 2. There were no significant differences (p>0.05) between control and all formulations on the cooking yield and shrinkage percentage. The cooking yield of the buffalo patties ranged from 8678% to 90.36% with the control formulation has a lower cooking yield of 86.76% and formulation of highest FCH incorporation has the highest cooking yield of 90.3%. This situation was supported by the data observed with the shrinkage percentage at the range of 18.11% to 22.54%. Control formulation has highest fat content shows highest shrinkage percentage of 22.54% while formulation with 50% FCH and fat has the lowest shrinkage percentage. The previous study by Soncu *et al.*, [23] suggested shrinkage percentage influenced by the amount of fat in hamburger as fat was removed during cooking, shrinkage increased. A study by Darwish *et al.*, [8] supported the fact of shrinkage percentage was directly proportional to fat in a frozen chicken burger. The same observation was obtained by Mohammad Nisar *et al*. [15] in their study of effect of tapioca starch as fat replacer in which they saw reduction of cooking loss as patties were replaced with higher percentage of starch flour due to the character of high water binding capability and stable protein matrix of starch flour as fat replacer. From the study conducted by Schilling *et al*., [22], the addition of pork collagen in exudative meat product resulted in a drop of shrinkage percentage and cooking loss due to the ability of collagen to work coherently with myofibrillar protein in meat product to bind water.

Table 2
Cooking yield, shrinkage percentage and water holding capacity (WHC) of buffalo patties formulated with different percentage of FCH

Treatments Variables	Control	A	B	C	D
Cooking Yield (%)	$86.78{\pm}3.03^a$	$93.31{\pm}5.71^a$	$91.34{\pm}2.74^a$	$89.60{\pm}6.64^a$	$90.32{\pm}2.22^a$
Shrinkage (%)	$22.54{\pm}0.40^a$	$22.78{\pm}4.57^a$	$18.11{\pm}1.91^a$	$19.65{\pm}2.38^a$	$20.17{\pm}1.24^a$
Water holding capacity (%)	$44.67{\pm}14.59^a$	$45.73{\pm}13.09^a$	$38.27{\pm}1.40^a$	$56.47{\pm}2.37^a$	$42.67{\pm}13.27^a$
pH raw beef patties	$6.34{\pm}0.07^a$	$6.21{\pm}0.08^a$	$6.22{\pm}0.07^a$	$6.17{\pm}0.10^a$	$6.14{\pm}0.15^a$
pH cooked beef patties	$6.18{\pm}0.07^a$	$6.18{\pm}0.06^a$	$6.08{\pm}0.11^a$	$6.07{\pm}0.03^a$	$6.03{\pm}0.04^a$

Means that do not share a letter are significantly different at level p<0.05. Control (10% fat, 0% FCH), A (7.5% fat, 2.5% FCH), B (5% fat, 5% FCH), C (2.5% fat, 7.5% FCH) and D (0% fat, 10% FCH).

3.2 Water Holding Capacity (WHC)

Water holding capacity (WHC) can be defined as the ability of the molecule to hold water, in this case referring to the ability of fat and FCH to hold water as a system in the formulation [3, 7]. Higher water holding capacity often associates to a higher moisture content in food in which generally macromolecules such as fat or protein holds water in the food system. From Table 2 above, the WHC on five different formulations of the buffalo patties obtained ranged from 38.27% to 56.47%. What is interesting with data obtained was there were no observable significant differences (p>0.05) on the different percentage of FCH incorporation as fat replacer on WHC even though protein and fat presence within the formulation should effect water dynamics and vicinity of the system [21]. A study conducted by Sousa *et al*., [24] reported increment in WHC of frankfurter formulation as the addition of hydrolyzed bovine collagen was increased. Their results were consistent with a study reported by Prestes *et al*., [20] in which effectively used of hydrolyzed collagen and others hydrocolloids (guar gums and modified starch) were able to retain water in processed turkey ham. Hydrolyzed collagen was predicted to interact with macromolecules and retained more water when compared to fat. However, data obtained from this experiment shows lowest WHC on buffalo patties with 50% FCH and fat composition of 38.27% while highest WHC was determined with the formulation of 75% FCH incorporation consistent with data reported by Sousa *et al*., [24] and Prestes *et al*., [20] but on different meat product i.e. buffalo patties. The WHC data was predicted to be directly proportional with moisture content in which higher WHC indicates higher protein-protein interaction and ability to retain water in the system of the meat product and hence produced higher moisture content with higher FCH incorporation.

3.3 pH measurements

As pH measurements is an important factor to monitor safety and quality in food products, WHC was also affected by pH value as it causes changes of protein-protein and protein-protein water interaction and hence influence texture and sensory properties of meat product. For the value presented in Table 2, there was no significant different (p>0.05) observed on buffalo patties formulated with a various concentration of FCH as fat replacer either on raw patties and cooked patties. The pH values of raw buffalo patties were recorded within the range of 6.14 to 6.34 while the pH value of cooked buffalo patties was ranged from 6.03 to 6.18. From the data, even though there was no significant difference between different formulations of both, pH value of raw patties recorded was slightly higher than cooked patties. In addition, from the pH value obtained for both raw patties and cooked patties, a correlation between FCH incorporation and pH value has been observed in which at the higher percentage of FCH, the lower the pH of both of raw patties and cooked patties. It was suggested that this is due to the property of the formulation being more acidic as more FCH added due to the properties of the FCH as the protein-based fat replacer.

3.4 Compositional analysis

The compositional analysis of cooked buffalo patties formulated with different percentage of FCH was presented in Table 3. The moisture content of the patties formulated with different percentage was significantly decreased (p<0.05) as the FCH increased at the level of more than 50%. The range of moisture content of the buffalo patties was from 63.35% to 71.04%. From a study conducted by Verma *et al*., [27], the moisture content in cooked ground pork patties was reduced as the fat content is higher was contradicting with the data obtained from the experimentation. This result was similarly obtained by Troutt *et al*., [25] on the study of ground beef patties. FCH is a fish collagen extracted from fish scales and undergone further hydrolysis treatment in which being converted to peptides molecule of smaller sizes [14]. Collagen extracted from waste such as visceral, skin and scale has three most abundant amino acid namely proline, hydroxyproline and alanine that made up most of the collagen peptides. These might suggest properties of FCH in binding water might be different from documented properties of collagen and gelatine as results obtained from this experiment, FCH does not act as hydrocolloid with good water holding the capacity to retain water and hence contribute to higher moisture content. This issue can be further investigated in for future reference.

Table 3
Compositional analysis of cooked buffalo patties formulated with different percentage of FCH as the fat replacer

Treatment Variables	Control	A	B	C	D
Moisture	71.04±0.15^{a}	69.18±0.37^{a}	68.10±0.21^{ab}	65.51±0.32^{b}	65.35±1.87^{b}
Protein	17.59±0.12^{c}	17.49±0.67^{c}	23.40±0.13^{b}	22.14±1.07^{b}	26.68±0.86^{a}
Fat	3.44±0.04^{c}	4.80±0.03^{a}	4.49±0.11^{b}	2.46±0.06^{e}	3.11±0.09^{d}
Ash	2.13±0.08^{a}	2.10±0.10^{a}	2.14±0.13^{a}	2.26±0.04^{a}	3.06±1.01^{a}

Means that do not share a letter are significantly different at level p<0.05. Control (10% fat, 0% FCH), A (7.5% fat, 2.5% FCH), B (5% fat, 5% FCH), C (2.5% fat, 7.5% FCH) and D (0% fat, 10% FCH).

Interestingly, data obtained for protein content in buffalo patties formulated with different FCH percentage was consistent with its protein increment in which significantly different (p<0.05) as higher FCH incorporation resulted in higher protein content in the patties. The highest protein content was determined by formulation incorporated with 100% FCH with the value of 26.63. The significant differences (p<0.05) were observed between the patties with different percentage of FCH in which patties with 75% FCH and 25% fat depicts lowest fat reading of 2.46 when compared to control formulation of 0% FCH and 100% fat. Patties handling, storage, processing and sampling might contribute to the interesting result obtained with moisture content and fat analysis. The incorporation of FCH at different percentage was not significant (p>0.05) with the ash value obtained.

3.5 Texture analysis

The mean values of TPA parameters are depicted in Table 4. Overall, the significant differences (p>0.05) was observable only on the cohesiveness parameter of the buffalo patties formulated with different percentage of FCH. Other parameters such as hardness, adhesiveness, springiness, gumminess and resilience of the buffalo patties were not significant (p<0.05). However, there was an observable trend in such parameters even though there were not significant. For hardness, springiness, gumminess and resilience, there were observed that buffalo patties formulated with higher FCH percentage of 50-75% depicts higher value compared to formulation with lesser or no FCH. A similar result of chewiness of Frankfurt sausages formulated with collagen from pig skin and wheat fat and sausages incorporated with hydrolyzed bovine collagen [6, 24].

Interest result was denoted with the cohesiveness of the buffalo patties in which formulation with 75% FCH resulted in lowest cohesive parameter while formulation with 50% FCH being the most cohesive. Moreover, Crehan *et al.*, [7] found that fat reduction in sausages increases springiness consistent with data obtained from the experimentation; however, a decrease in adhesiveness was not observed with buffalo patties with lower fat content. Same goes with the result obtained by Noriham *et al.*, [16] in which the usage of okara flour as fat replacer reduced hardness, cohesiveness, springiness and chewiness of sausages formulation as fat was reduced throughout formulations. The result obtained from the experiment suggest incorporation of FCH in patties dictates by the property of the hydrolyzed collagen in which might work similarly like carrageenan in which capable in improving the cohesiveness of cooked sliced meat [9].

Table 4
Texture profile analysis of cooked buffalo patties formulated with different percentage of FCH as the fat replacer

Treatment Variables	Control	A	B	C	D
Hardness	1606.3±28.2[a]	1877.4±79.5[a]	723.90±3.30[a]	2381±1254.10[a]	1167.0±194.20[a]
Adhesiveness	-151.80±43.10[a]	-214.70±99.22[a]	-207.50±118.70[a]	-257.70±211.00[a]	-137.10±5.40[a]
Springiness	0.35±0.03[a]	0.73±0.40[a]	1.13±0.57[a]	1.04±1.09[a]	1.37±1.22[a]
Cohesiveness	0.28±0.04[ab]	0.30±0.08[ab]	0.39±0.09[b]	0.17±0.05[a]	0.33±0.09[ab]
Gumminess	412.10±32.30[a]	470.00±5.80[a]	388.60±172.30[a]	518.80±264.80[a]	282.10±82.80[a]
Resilience	147.10±7.10[a]	341.0±182.30[a]	381.4±44.60[a]	440.6±330.00[a]	437.00±495.00[a]

Means that do not share a letter are significantly different at level p<0.05. Control (10% fat, 0% FCH), A (7.5% fat, 2.5% FCH), B (5% fat, 5% FCH), C (2.5% fat, 7.5% FCH) and D (0% fat, 10% FCH).

3.6 Colour measurements

Colour is one of the extrinsic factors that influence customer satisfaction and preferences towards meat products [26]. Based on table 5 above, there was no significant difference observed with the lightness (L*), redness (a*) and yellowness (b*) of the buffalo patties of different percentage of FCH for raw patties. However, the observable trend within all patties were, the higher the FCH percentage, the darker the buffalo patties, the redness was reduced and the yellowness reduced within the range of 8.74 to 11.50 for L*, 7.91 to 10.52 for a* and 6.14 to 7.92 for b*.

Table 5
Colour measurements of raw and cooked buffalo patties formulated with different percentage of FCH

Treatments Variables		Control	A	B	C	D
Raw patties	Lightness (L*)	11.50±1.16[a]	10.57±2.70[a]	8.77±1.90[a]	9.49±1.59[a]	8.74±0.74[a]
	Redness (a*)	10.52±1.14[a]	9.76±2.53[a]	8.02±1.84[a]	8.56±1.71[a]	7.91±0.74[a]
	Yellowness (b*)	7.92±0.83[a]	7.41±1.14[a]	6.14±1.23[a]	6.63±1.19[a]	6.11±0.42[a]
Cooked patties	Lightness (L*)	36.61±0.27[a]	34.81±1.46[a]	31.80±1.51[b]	29.63±0.44[b]	30.49±0.38[b]
	Redness (a*)	6.54±0.34[a]	7.28±0.41[a]	7.14±0.80[a]	7.52±0.60[a]	7.51±0.85[a]
	Yellowness (b*)	9.96±0.34[a]	11.85±1.96[a]	12.37±1.46[a]	8.89±1.40[a]	10.66±1.73[a]

Means that do not share a letter are significantly different at level p<0.05. Control (10% fat, 0% FCH), A (7.5% fat, 2.5% FCH), B (5% fat, 5% FCH), C (2.5% fat, 7.5% FCH) and D (0% fat, 10% FCH).

An interesting observation was found with cooked patties in which the patties lightness were significantly different (p<0.05) as the amount of FCH increased. The lowest lightness (darkest) was observed with patties of 7.5% FCH while the lightest patties were with control formulation of % FCH. As consumer perception is dictated by colour especially for meat produce (the more red, the fresher the product) whereas for the cooked meat product, for example with cooking preparation via grilling, the darker (brown) the meat, the more palatable the product. Not only that, as FCH is a protein-based fat replacer, the reduced in the lightness of the product might contribute to the fat of higher protein content and the process of Maillard browning might take place as the protein content might be increased. Others parameter of a* and b* of the cooked patties were not significant.

3.7 Sensory evaluation

Table 6
Sensory evaluation cooked buffalo patties formulated with different percentage of FCH

Treatment Variables	Control	A	B	C	D
Colour	4.00±0.94[a]	4.07±0.69[a]	3.80±0.84[a]	3.93±0.78[a]	3.57±0.86[a]
Flavour	4.00±0.78[a]	4.00±0.78[a]	3.70±1.02[ab]	3.63±1.10[ab]	3.07±1.17[b]
Appearance	4.00±0.69[a]	3.70±0.65[a]	3.73±0.94[a]	3.93±0.78[a]	3.50±0.86[a]
Juiciness	3.83±0.69[a]	3.93±0.69[a]	3.60±0.86[a]	3.97±0.77[a]	3.43±1.10[a]
Texture	4.07±0.74[a]	3.93±0.78[a]	3.70±0.91[ab]	3.67±1.06[ab]	3.23±1.19[b]
Aroma	3.80±0.76[a]	3.70±0.70[a]	3.60±0.89[a]	3.80±0.92[a]	3.30±1.17[a]
Overall acceptability	3.93±0.86[ab]	4.07±0.64[a]	3.67±1.03[ab]	3.77±0.93[ab]	3.30±1.18[b]

Means that do not share a letter are significantly different at level $p<0.05$. Control (10% fat, 0% FCH), A (7.5% fat, 2.5% FCH), B (5% fat, 5% FCH), C (2.5% fat, 7.5% FCH) and D (0% fat, 10% FCH).

The buffalo patties formulated with different percentage of FCH were evaluated for attributes of colour, flavour, appearance, juiciness, texture, aroma and overall acceptability. From table 6 above, the attributes that were significantly different ($p>0.05$) were on flavor, texture and overall acceptability of the buffalo patties formulated with different percentage of FCH. All these attributes were important for consumer preferences for palatability of food products [1, 26]. Furthermore, the addition of soybean as additives in soy beef patties seems to not affecting its sensorial test as conducted by Bowers and Engler [5]. It seems that from hedonic overall acceptability score, buffalo patties formulated with 25% FCH liked the most, followed by control, 75% FCH incorporation, 100% FCH incorporation and least liked was formulation with 50% FCH. However, there was no significant difference of patties formulated with 25% FCH and control for all attributes except on its overall acceptability. The least liked formulation was observed with the formulation with 100% FCH. Therefore, this result suggests palatability and acceptance of consumer for FCH to be used as fat replacer was only to the level of 75% FCH incorporation. The higher the FCH content reduced its flavor and texture as observed from colour analysis and texture in which high in cohesiveness and brown in the colour was not physically attractive to the consumer for buffalo patties formulation.

4. Conclusion

In overall, the fat content in the buffalo patties can be replaced with up to 7.5% (w/w) FCH as in formulation C. This is based on its higher protein content, lower fat content, and similar sensory acceptability as compared to the control sample and other formulations. The textural properties were also insignificantly different ($p<0.05$) in all formulations, except for the cohesiveness which was highest in sample B (50% FCH). This finding suggested the ability of FCH in contributing to this textural property. Upon cooking, patties with higher FCH content exhibited a darker colour which may be due to Maillard Browning reaction. This study shows the potential of FCH as a fat replacer in buffalo patties. Further studies are therefore recommended in using FCH as a fat replacer in other types of meat-based food products.

References

[1] Babji, A. S., Mukhlis, I., Gna, S. K., Seri Chempaka, M. Y., Norhaliza, M., & Eraou, B. "Processing efficiency and physicochemical properties of surimi type materials." *Malaysian Journal of Animal Science,* 1, (1995): 52-58.

[2] Barzideh, Z., Latiff, A. A., Gan, C. Y., Abedin, M., & Alias, A. K. "ACE inhibitory and antioxidant activities of collagen hydrolysates from the ribbon jellyfish (Chrysaora sp.)." *Food technology and biotechnology* 52, no. 4 (2014): 495-504.

[3] Bastos, S. C., Pimenta, M. E. S. G., Pimenta, C. J., Reis, T. A., Nunes, C. A., Pinheiro, A. C. M., Fabricio, L. F. F., & Leal, R. S. "Alternative fat substitutes for beef burger: technological and sensory characteristics." *Journal of Food Science and Technology* 51, no. 9 (2014): 2046-2053.

[4] Bourne, M. C., Kenny, J. F., & Barnard, J. "Computer-assisted readout of data from texture profile analysis curves." *Journal of Texture Studies* 9, no. 4 (1978): 481-494.

[5] Bowers, J. A. & Engler, P. P. "Freshly cooked and cooked, frozen reheated beef and beef-soy patties." *Journal of Food Science* 40, no. 3 (1975): 624-625.

[6] Choe, J. H., Kim, H. Y., Lee, J. M., Kim, Y. J., & Kim C. J. "Quality of frankfurter-type sausages with added pig skin and wheat fiber mixture as fat replacers." *Meat science* 93, no. 4 (2013): 849-854.

[7] Crehan, C. M., Hughes, E. Troy, D. J., & Buckley. D. J. "Effects of fat level and maltodextrin on the functional properties of frankfurters formulated with 5, 12 and 30% fat." *Meat Science* 55, no. 4 (2000): 463-469.

[8] Darwish, S. M. I., El-Geddawy, M. A. H., Khalifa, R. M. B., & Mohamed, R. A. A. "Physico-chemical changes of frozen chicken burger formulated with some spices and herbs." *Frontiers in Science* 2, no. 6 (2012): 192-199.

[9] Daud, N. A., Ghassem, M., Fern, S. S., & Babji, A. S. "Functional bioactive compounds from freshwater fish, edible birdnest, marine seaweed and phytochemical." *American Journal of Food and Nutrition* 6, no. 2 (2016): 33-38.

[10] Dybka, K. A., & Walczak, P. "Collagen hydrolysates as a new diet supplement." *Food Chemistry and Biotechnology* 73, (2009): 83-92.

[11] Hashim, P., Mohd Ridzwan, M. S., Bakar, J., & Mat Hashim, D. "Collagen in food and beverage industries." *International Food Research Journal* 22, no. 1 (2015): 1-8.

[12] Keeton, J. T. "Low-fat meat products—technological problems with processing." *Meat Science* 36, no. 1-2 (1994): 261-276.

[13] Kohn, C. R., Fontoura, A. M., Kempka, A. P., Demiate, I. M., Kubota, E. H., & Prestes, R. C. "Assessment of different methods for determining the capacity of water absorption of ingredients and additives used in the meat industry." *International Food Research Journal* 22, no. 1 (2015): 356-362.

[14] Mahboob, S. "Isolation and characterization of collagen from fish waste material-skin, scales and fins of Catla catla and Cirrhinus mrigala." *Journal of food science and technology* 52, no. 7 (2015): 4296-4305.

[15] Mohammad Nissar, P. U., Chatli, M. K., & Sharma, D. K. "Efficacy of tapioca starch as a fat replacer in low-fat buffalo meat patties." *Buffalo Bulletin* 28, no. 1 (2009): 18-25.

[16] Noriham, A., Muhammad Ariff Aizuddin, R., Noorlaila, A., & Faris Zakry, A. N. "Potential use of okara as meat replacer in beef sausage." *Jurnal Teknologi* 78, no. 6-6 (2016): 13-18.

[17] Official methods of analysis, 16th Ed. Association of Official Analytical Chemists, Washington, DC.

[18] Ognean, C. F., Darie, N., & Ognean, M. "Fat replacers: review." *Journal of Agroalimentary Processes and Technologies* 12, no. 2 (2006): 433-442.

[19] Phrabu, G.A., Doerscher, D.R., & Hull, D.H. "Utilization of pork collagen protein in emulsified and whole muscle meat products." *Journal of food science* 69, no. 5 (2004): 388-392.

[20] Prestes, R. C., Carneiro, E. B. B., & Demiate, I. M. "Hydrolyzed collagen, modified starch and guar gum addition in turkey ham." *Ciência Rural, Santa Maria* 42, no. 7 (2012): 1307-1313.

[21] Puolanne, E., & Halonen, M. "Theoretical aspects of water-holding in meat." *Meat Science* 86, no. 1 (2010): 151-165.

[22] Schilling, M. W., Mink, L. E., Gochenour, P. S., Marriott, N. G., & Alvarado, C. Z. "Utilization of pork collagen for functionality improvement of boneless cured ham manufactured from pale, soft, and exudative pork." *Meat Science* 65, no. 1 (2003): 547-553.

[23] Soncu, E. D., Kolsarıcı, N., Cicek, N., Öztürk, G. S., Akoğlu, i. T., & Arıcı, Y. K. "The comparative effect of carrot and lemon fiber as a fat replacer on physico-chemical, textural, and organoleptic quality of low-fat beef hamburger." *Korean Journal of Food Science and Animal Resources* 35, no. 3 (2015): 370-381.

[24] Sousa, S. C., Fragoso, S. P., Penna, C. R. A., Arcanjo, N. M. O., Silva, F. A. P., Ferreira, V. C. S., Barreto, M. D. S., & Araujo, I. B. S. "Quality parameters of frankfurter-type sausages with partial replacement of fat by hydrolyzed collagen." *LWT-Food Science and Technology* 76, (2017): 320-325.

[25] Troutt, E. S., Hunt, M. C., Johnson, D. E., Claus, J. R., Kastner, C. L., Kropf, D. H., & Stroda, S. "Chemical, physical, and sensory characterization of ground beef containing 5 to 30 percent fat." *Journal of Food Science* 57, no. 1 (1992): 25-29.

[26] Troy, D. J., & Kerry, J. P. "Consumer perception and the role of science in the meat industry." *Meat science* 86, no. 1 (2010): 214-226.

[27[Verma, A. K., Chatli, M. K., Kumar, D., Kumar, P., & Mehta, N. "Efficacy of sweet potato powder and added water as fat replacer on the quality attributes of low-fat pork patties." *Asian-Australasian journal of animal sciences* 28, no. 2 (2015): 252-259.