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Chemical, Physical and Sensory Evaluation of Low Fat Beef Burger with Carboxymethyl Cellulose Produced From Rice and Wheat Bran

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ABSTRACT

This investigation was carried out to study the possibility of produce of carboxymethyl cellulose (CMC) from rice and wheat bran and used as fat replacers in preparing low fat beef burger was added by substitution of fat at levels of 1.0,1.5 and 2.0%. Characterizations of CMC were analyzing by the spectra of FTIR, Degree of substitution (DS), water holding capacity, oil holding capacity and swelling capacity. Furthermore, gross chemical composition, physical properties, cooking characteristics of beef burger were determined. Results indicated that, Rice bran had significantly the highest content of crude protein , ether extract and cellulose content compared with wheat bran on contrast, wheat bran had a significantly higher percentage of ash , total carbohydrate and hemicellulose (11.91, 60.48and 49.85% , respectively) than that of rice bran. The CMC%, Degree of substitution (DS), water holding capacity, oil holding capacity and swelling capacity of CMC produced from rice bran are significantly higher than that of wheat bran. addition to, CMC increase the amount of moisture, carbohydrates and crude fiber and decrease the amount of fat in compare with control beef burger sample. Statistical analysis for physical properties indicated that there were a significant differences in both shrinkage and diameter reduction, while no differences were observed in Texture Profile Analysis(TPA) for beef burger formulas prepared with CMC compared with control beef burger. So this research suggests that CMC is effective in improving physical, chemical and functional properties of beef burger.

Keywords: low fat beef burger, fat replacer, carboxymethyl cellulose, rice bran, wheat bran

1. Introduction

In recent years, the agro waste materials have created intensive research interest of scientists to use in technology development due rich content and poor waste management technology.

One of the potential agro-wastes are rice bran (RB) and wheat bran (wb) which are available in large quantity as food industrial by-products.(Oliveira *et al*., 2017).

Rice bran is one of the major byproduct generated during the rice milling process. Rice bran represent approximately 8 % of the dry weight of the rice harvest. Rice bran rich in dietary fiber consists of hemicelluloses 21.08%, mainly arabinoxylan, cellulose 33.60% and lignin 5% (Hussein and Ibrahim (2019).

Wheat bran is separated from the other parts of the wheat kernel by milling, and the chemical composition of wheat bran predominantly comprises non-starch polysaccharides 38%, starch 19% , protein 18% and lignin 6%, with the non-starch polysaccharides being approximately 70% arabinoxylans, approximately 19% cellulose and approximately 6% β-(1,3)/β-(1,4)-glucan. (Hussein and Ibrahim, 2019 and Manali and Dr Savita., 2019). So, rice bran and wheat bran are a cheap and rich source of cellulose.

Cellulose can hardly exist in pure form but can be found in the plant cell wall with hemicellulose and lignin (Pushpamalar *et al*., 2006). Its isolation can be possible, utilizing accessible less expensive chemicals that produce physical and chemical properties better than cellulose obtained commercially.

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It serves as a starting material for the synthesis of carboxymethyl cellulose and its derivatives, cellulose acetate, methylcellulose, cellulose nitrate, and ethyl cellulose. Being a polysaccharide, it is formed as a result of the repeating unit of D-glucose, linked by glycosidic linkage β (1-4). The presence of three reactive hydroxyl groups (C2, C3, and C6) on each glucan unit of cellulose makes it relatively easy to modify , Purified CMC is a white to cream colored, tasteless, odorless, free-flowing powder and used in a variety of industries including the food, detergents, personal care, pharmaceutical etc.(Mondal, *et al*., 2015).

Recent studies have established relationship between meat consumption and increased risk of suffering serious health disorders such as colorectal cancer and coronary-heart diseases. There is an advice from health organizations to reduce the amount of dietary fat to reduce the risks of chronic disease such as coronary heart disease, some types of cancer and obesity (Haward *et al*., 2006).

Fat is an important ingredient in processed meats furthermore, Fat plays an important role in the texture and water-binding capacity (WBC) of meat products, the decrease on the fat content usually negatively affects final product appearance, flavor, and texture (Furlán, *et al*., 2014).The major problem in acceptability of low-fat processed meat products is the decline in palatability with fat reduction (Mansour and Khalil, 1997).

Recent studies have shown that some ingredients can be added as fat replacers in meat products, such as carboxymethyl cellulose (CMC) (Furlán *et al*., 2014; Gibis *et al*., 2017).The abilities of CMC acting as a fat replacer, emulsion stabilizer and thickener have been explored in dairy and bakery products as well as in low-fat meat products, such as emulsified sausages and burger patties (Ulu, 2005). So, this research was aimed to evaluate the effect of addition different levels of carboxymethyl cellulose produced from rice and wheat bran as a fat replacers on physical, chemical characteristics and sensory evaluation of low fat beef burger.

2. Materials and Methods

2.1. Materials

2.1.1. Agro-industrial by-products:

A. Rice bran (RB) variety Sakha 101 were obtained from the Rice Research and Training Center(RRTC), Sakha , Kafer El-Sheikh , Egypt , Season 2019 and stored in deep freeze at -20°C until further use.

B. Wheat bran (Wb) was purchased from Delta Middle and West Milling Company, Tanta, Egypt, Season 2019 and stored in deep freeze at -20°C until further use.

C. Beef meat and other ingredients used to prepare beef burger (spices mixture, garlic, onion, sunflower oil and salt) were obtained from local market at Kafr El-Sheikh city, Egypt.

D. Chemicals: All chemicals used in current study were obtained from El-Gomhoria Company for Chemical and Drugs Tanta, Egypt.

2.2. Methods

2.2.1. Preparation of Agro-industrial by-products

A. Rice and wheat bran were air dried at 40°C for 1 hr. and ground into fine power and stored in the polyethylene bags in the deep freezer at -20°C until use (Salem *et al* ., 2018).

B. Extraction of oil from rice and wheat bran were Implemented using the method described by A.O.A.C. (2005).

C. Elimination of starch from rice and wheat bran described by Zhou *et al*. (2010).

D. Removal of protein from destarched and defatted rice and wheat bran according to Chanput *et al*. (2009).

E. Extraction of cellulose from deprotein, destarched and defatted rice and wheat bran as described by (Adinugraha *et al*., 2005)

F. Production of sodium carboxymethyl cellulose from rice and wheat bran using the method reported by Adinugraha *et al*., (2005).

2.3. Gross chemical composition of Agro-industrial by-products

Moisture, crude protein, ether extract, ash, crude fiber and of samples were determined according to A.O.A.C. (2005).

Total carbohydrates content was calculated by subtracting protein, ash and ether extract contents from the total mass of 100 as reported by Tadrus (1989).

Lignin content in the investigated materials was determined according to the method described by Bledzki *et al*. (2010).

Acid insoluble ash (silica) was determined according to the method of A.O.A.C. (2005).

2.4. Characterization CMC

A. The infrared spectroscopic analysis was carried out for commercial CMC and CMC produced from rice and wheat bran using the KBr method described by Pushpamalar *et al*. (2006).
B. Determinations of degree of substitutions of samples were determined according to the methods of Pushpamalar *et al*. (2006).
C. Determination of NaCl content of CMC was carried out by ASTM. (2003)
D. Swelling Capacity was determined simultaneous as the hydration capacity using the method of Okhamafe *et al*. (1991).
E. Water Solubility Index (WSI) of Carboxymethyl cellulose was determined as described by Anderson and Sefa-dadeh (2001).
F. The pH of the sample was determined as that of the supernatant after shaking 1 g in 30 ml of distilled water for 10 min with a pH meter (Ejikeme, 2008).
G. Water holding capacity (WHC) and oil-holding capacity (OHC):-
Twenty-five milliliters of distilled water or commercial olive oil were added to 1 g of dry sample, stirred and incubated at 40°C for 1 h. After centrifugation, the residue was weighed and WHC and OHC calculated as g water or oil per g of dry sample respectively (Larrauri *et al*. 1996).

2.5. Preparation of beef burger and their formulae

Beef burger samples were formulated according to **Aleson-Carbonell *et al.* (2005) and** the ingredients tabulated in table (A). Burger formulas were made using a petri dish to obtain round discs 9cm diameter and 1cm thickness.

The prepared burgers were packaged by individually in polyethylene film to help maintaining the shape of burger prior to freezing. The samples were frozen at –18 °C prior to analysis.

Table A: Ingredients of prepared beef burgers containing carboxymethyl cellulose produced from rice and wheat bran at levels (1.0, 1.5 and2.0 %).

Ingredients	Level addition	Beef Meat	Beef Back Fat	Ice water	Spice mixture	Dried onion	Dried garlic	NaCl
Control	-	65	15	10.5	1.5	3	3	2
	1.0	65	14	10.5	1.5	3	3	2
CMC_1	1.5	65	13.5	10.5	1.5	3	3	2
	2.0	65	13	10.5	1.5	3	3	2
	1.0	65	14	10.5	1.5	3	3	2
CMC_2	1.5	65	13.5	10.5	1.5	3	3	2
	2.0	65	13	10.5	1.5	3	3	2

CMC_1= carboxymethyl cellulose produced rice bran **CMC_2**= carboxymethyl cellulose produced wheat bran

2.5.1. Cooking of Beef Burger

The beef burger studied samples were cooked using an electrical grill (Arcelik Mini Firin, Turkey) at 300 °C (the distance between heat source and the sample was 4 cm) for a total of 10 min, 6 min one side and 4 min in the other side (Turhan *et al*., 2005).

2.6. Physical properties and feder value

2.6.1. Water Holding Capacity (WHC) and Plasticity

Water Holding Capacity (WHC) was measured using the method of El-Seesy (2000) by the following equations:

$$Free\ water\ (\%) = \frac{Total\ surface\ area\text{-}\ Meat\ film\ area,\ mm(6.11)}{Total\ moisture\ (mg)\ in\ meat\ sample} \times 100$$

WHC (%) = 100- free water
Plasticity (cm^2) = Meat film area (Internal area)

2.7. Texture indices

Protein water coefficient (PWC) and protein-water-fat coefficient (PWFC) were calculated according to Tsolaze, (1972) using the following equations:

$$PWC = \frac{\%\ Protein}{\%\ water} \qquad PWFC = \frac{\%\ Protein}{\%\ water + fat}$$

Feder value which is used for assessing one of the quality attributes in meat was calculated according to Pearson, (1970) using the following equation:

$$Feder\ value = \frac{\%\ Water}{\%\ Organic\ non\ fat}$$

Where % organic nonfat = 100 – (% Moisture + % Fat + % Ash).

2.8. Cooking characteristics

2.8.1. Texture Profile Analysis

Texture was determined in Food Technology Research. Institute, Agricultural Research Center Giza- Egypt, by a universal testing machine (Cometech, B type, Taiwan) provided with software. An Aluminum 25 mm diameter cylindrical probe was used in a “Texture Profile Analysis” (TPA) double compression test to penetrate to 50% depth, at 1 mm/s speed test. hardness (N/cm^2), gumminess (N/cm^2), chewiness (N/cm^2), cohesiveness (ratio), and springiness(cm) were calculated from the TPA graphic (Bourne, 2003).

2.8.2. Shrinkage

Shrinkage percentage was calculated as described by A.M.S.A, (1995) as follows:

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

2.8.3. Diameter reduction

Changes in beef burgers diameter was calculated by Gok *et al. (*2011) using the following equation:

$$\%\ Diameter\ Reduction = \frac{Un\ cooked\ diameter\text{-}\ Cooked\ diameter}{(Un\ cooked\ diameter} \times 100$$

2.8.4. Cooking loss

Cooking loss of the beef burger was calculated according to A.M.S.A, (1995) using the following equation:

$$\%\ Cooking\ loss = \frac{Raw\ sample\ weight\ (g) - Cooked\ sample\ weight(g)}{Raw\ sample\ weight\ (g)} \times 100$$

2.8.5. Cooking yield

Cooking yield of the beef burger was determined by measuring the weight of three burgers for each treatment/batch Gok *et al., (*2011) and calculating weight differences for burgers before and after cooking, as follows:

$$\%\ Cooking\ yield = \frac{Cooked\ weight(g)}{Raw\ weight\ (g)} \times 100$$

2.8.6. Sensory evaluation

The Sensory characteristics of the cooked burger samples were carried out by well-trained 20 panelists of Food Technology Research Institute (FTRI). Panelists were asked to evaluate color, texture, taste, appearance and overall acceptability, of cooked samples according to the method described by (A.M.S.A, 1995).

Statistical analysis

Data were analyzed according to Steel and Torrie (1980) procedures (Duncan's multiple range test DMRT).

3. Results and Discussions

3.1. Proximate chemical composition of rice and wheat bran

Proximate chemical composition of rice and wheat bran are given in Table (1) .The obtained results indicated that, rice bran had significantly higher contents of crude protein, ether extract, crude fiber and cellulose than rice hull (14.30, 18.00,14.13,and 23.45%, respectively) compared to that of wheat bran . Meanwhile, wheat bran contained higher amount of ash, total carbohydrate and hemicellulose (11.91, 60.48and 49.85%, respectively) than that of rice bran (8.90, 44.67 and 28.11 % respectively). Also, rice bran contain more moisture content (8.30%) than the wheat bran (8.12%), although the difference is not significant. The obtained results agree partially with those of El-Sharnouby *et al*. 2012, Salem *et al.* (2018) and Hussein and Ibrahim (2019).

Table 1: Gross chemical composition of rice and wheat bran on dry weight basis.

Component / Samples	Rice bran	Wheat bran
Moisture	8.30 ^{a}±0.12	8.12 ^{a} ±0.22
Crude protein	14.30 ^{a}± 0.19	10.30 ^{b} ±0.12
Ether extract	18.00 ^{a}± 0.08	6.90 ^{b} ±0.10
Ash content	8.90 ^{b}±0.12	11.91 ^{a} ±0.13
Crude fiber	14.13 ^{a}±0.18	10.41^{b} ±0.11
Carbohydrate*	44.67 ^{b}±0.84	60.48 ^{a} ±0.87
Cellulose	23.45 ^{a} ±0.21	14.45^{b} ±0.18
Hemicellulose	28.11 ^{b}±0.19	49.85 ^{a} ±0.10
Lignin	5.60 ^{a} ±0.13	5.85 ^{a} ±0.11
Silica	0.96 ^{a} ±0.04	0.18 ^{b} ±0.09

Each value is an average of three determinations ± standard deviation
Values followed by the same letter in rows are not significantly different at P<0.05 Carbohydrate* were calculated by differences

3.2. Physicochemical characteristics of carboxymethyl cellulose

Physicochemical properties of carboxymethyl cellulose produced from rice and wheat bran compared to commercial are given in Table (2).

Data in table (2) showed that, carboxymethyl cellulose produced from rice bran, had a high Degree of substitution(DS) and CMC% (0.78 and 65.8 respectively) following Commercial CMC which had DS and CMC% (0.76 and 59.75 respectively) then CMC produced from wheat bran which had DS and CMC% (0.73 and 59.10%). These results agree with Togrul and Arslan. (2003) Apparent also, from the same Table that, no significant differences were found in moisture, ash content , Nacl % and PH values between CMC produced from rice and wheat bran and commercial CMC.

These results are supported by Adinugraha *et al* .(2005) On the other hand, it can be demonstrated that Water holding capacity (WHC) and oil holding capacity (OHC) of carboxymethyl cellulose produced from rice and wheat bran are significantly higher than that of commercial CMC. These results are completely in agree with the those obtained by Latif *et al*.(2007) and Mondal *et al*.(2015) From the previous results, it can be deduced that, carboxymethyl cellulose produced from rice bran, was found to have the highest value for swelling capacity (802.12%) while carboxymethyl cellulose produced from wheat bran showed the least swelling capacity (787.88%), which is directly proportional to their DS respectively. Meanwhile, carboxymethyl cellulose produced from wheat bran had the least swelling capacity and water solubility index, which is directly proportional to their DS respectively. These results are agree with Ernest *et al.*(2016) they found that, swelling capacity and water solubility index could have been influenced by their DS .

Table 2: Studying physicochemical characteristics carboxymethyl cellulose produced from rice and wheat bran compared to commercial CMC.

Samples / Parameters	CMC_1	CMC_2	Commercial CMC
Degree of substitution	0.78^{a} ±0.04	0.73^{ab} ±0.03	0.76^{a} ±0.02
CMC%	65.80^{a} ±0.19	59.10^{b}±0.19	59.75^{b}±0.17
Moisture	3.40^{a} ±0.11	3.46^{a}±0.19	3.42^{a}±0.14
Ash content %	14.87^{a} ±0.24	14.60^{a}±0.18	14.70^{a}±0.23
WHC g/g	4.47^{a}±0.11	4.25^{ab}±0.09	4.09^{b}±0.12
OHC g/g	1.69^{a}±0.04	1.61^{ab} ±0.03	1.50^{b} ±0.01
Swelling capacity	802.12^{a} ±1.94	787.88^{c}±3.71	800.72^{b}±1.53
WSI	56.21^{a} ±0.63	47.00^{c}±0.19	53.65^{b}±0.25
NaCL %	0.019^{a} ±0.002	0.020^{a}±0.006	0.022^{a}±0.003
pH	6.93^{a} ±0.14	6.97^{a}±0.13	6.84^{a}±0.11

Each value is an average of three determinations ± standard deviation
Values followed by the same letter in rows are not significantly different at $P<0.05$
CMC_1,CMC_2 as shown in table(A)

3.3. Infrared spectroscopy (IR)

The infrared spectra were studied to confirm the substitution reaction in carboxymethylation. The infrared spectra of cellulose, carboxymethyl cellulose produced from rice and wheat bran compared to pure cellulose and commercial carboxymethyl cellulose were presented in Figure 1. Specific vibrations can be found in infrared spectra since this method provide information on molecular vibrations. The cellulose and CMC in each condition were provided the same functional groups. The broad absorption band at 3432 cm^{-1} is due to the stretching frequency of the –OH group. The band at 2920 cm^{-1} is due to C–H stretching vibration. The bands around 1420 and 1320 cm^{-1} are assigned to $–CH_2$ scissoring and –OH bending vibration, respectively.

The band at 1060 cm^{-1} is due to $–CH–O–CH_2$ stretching (Pushpamalar *et al.* 2006; Rachtanapun *et al.* 2007) From the representative spectrum of carboxymethyl cellulose produced from rice and wheat bran compared to commercial carboxymethyl cellulose, the strongest absorbance were at 1608, 1419 and 1055cm^{-1}. This result was indicated the presence of carboxymethyl substituent from CMC synthesis at COO–, $–CH_2$ and –O– group (Adinugraha *et al.*2005 and Rachtanapun *et al.* 2007). According to Adinugraha *et al.*(2005), carboxyl (COO–) groups as its salts have wave number about 1600–1640 cm^{-1} and 1400–1450 cm^{-1}. The similar observations have been reported previous by Adinugraha *et al.* (2005) and Rachtanapun *et al.* (2007). This result corroborated that CMC could be produced from rice and wheat bran.

3.4. Proximate chemical composition of beef burger containing CMC produced from rice and wheat bran with different level of CMC % as a fat replacer

Carboxymethyl cellulose(CMC) produced from rice and wheat bran were used to replace fat with levels 1.0, 1.5 and 2.0 % in beef burger formula, and the resultant uncooked and cooked beef burger were subjected to proximate chemical analysis and the results are shown in Table (3)

It should be noted from the given data that, moisture content of uncooked and cooked beef burger were increased gradually as a function of increasing the percentage of CMC replacement level to beef burger. The increment of moisture content may be due to the capability of CMC rich with fiber to hold more water via preparation and cooking process .These results are in agreement with Kılıncceker and Kurt (2018) who stated that dietary fiber source has the capacity to hold three or four times its weight of water. Furthermore , The moisture content of the low fat formulations increased concomitantly with

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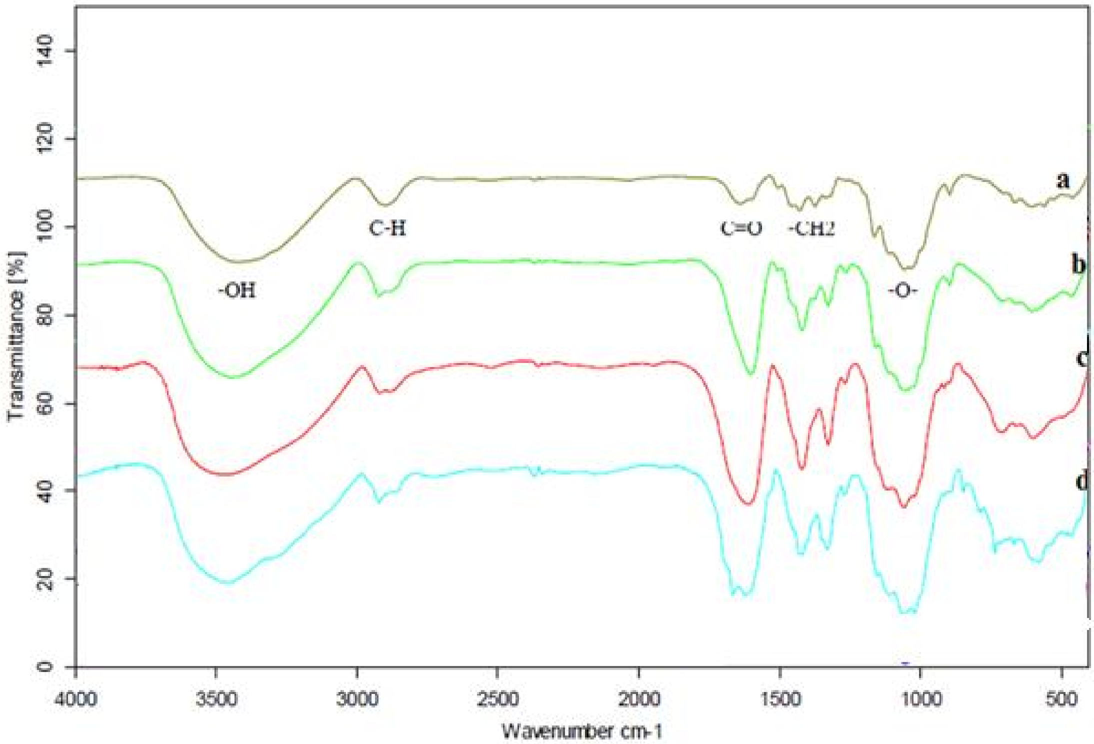
Table 3: Proximate chemical composition of beef burger with different levels of carboxymethyl cellulose produced from rice and wheat bran as fat replacer (on dry weight basis).

Component %		Moisture	Protein	Ether extract	Ash	Crude fiber	*T. C	Moisture	Protein	Ether extract	Ash	Crude fiber	*T. C
		Uncooked beef burger						**Uncooked beef burger**					
	0	59.98d ±0.71	42.55d ±0.34	38.43a ±0.28	4.01a ±0.14	2.89d ±0.09	15.01b ±0.21	53.64d ±0.49	34.89d ±0.25	31.13a ±0.34	5.93a ±0.11	3.65d ±0.15	28.05c ±0.18
CMC₁	**1**	60.54c ±0.48	44.44c ±0.18	36.31b ±0.75	4.00a ±0.18	4.33c ±0.16	15.25b ±0.15	55.33c ±0.37	35.66c ±0.21	29.10b ±0.36	6.24a ±0.18	5.17c ±0.30	29.00b ±0.19
	1.5	61.36b ±0.69	45.46b ±0.21	34.98c ±0.33	4.06a ±0.26	6.46b ±0.13	15.50ab ±0.10	56.36b ±0.44	35.79bc ±0.19	27.93c ±0.33	6.37a ±0.09	7.2b ±0.12	29.91ab ±0.13
	2.0	62.42a ±0.73	46.16a ±0.19	33.76d ±0.21	4.17a ±0.34	7.45a ±0.13	15.91a ±0.19	57.45a ±0.25	36.23b ±0.40	26.69d ±0.29	6.53a ±0.41	8.19a ±0.45	30.55a ±0.15
CMC₂	**1**	60.9c ±0.44	44.25c ±0.26	36.52b ±0.12	4.04a ±0.15	4.39c ±0.10	15.19ab ±0.20	55.80c ±0.19	35.18c ±0.21	29.41b ±0.41	6.31a ±0.21	5.31c ±0.19	29.10b ±0.12
	1.5	61.55b ±0.31	45.43b ±0.31	35.05c ±0.19	4.08a ±0.35	6.65b ±0.19	15.44ab ±0.24	56.36b ±0.28	35.79bc ±0.41	27.93c ±0.33	6.37a± 0.25	7.27b ±0.27	29.91ab ±0.20
	2.0	62.71a ±0.29	46.12a ±0.38	33.78d ±0.29	4.21a ±0.18	7.72a ±0.15	15.89a ±0.16	57.73a ±0.39	36.57b ±0.16	26.80d ±0.11	6.37a ±0.26	8.35a ±0.16	30.36a ±0.19

Each value is an average of three determinations
Values followed by the same letter in columns are not significantly different at P<0.05
*Carbohydrates were calculated by difference.
CMC1,CMC2,..... …are shown in table (A)

the increased level of CMC that could be due to fat substituted by moisture in the low fat products (Youssef *et al* ., 2012) For fat content, which was determined as ether extract, illustrated that the fat content of control beef burger had high amount of fat with significant difference than that of other treatments. Furthermore, fat content of all beef burger containing CMC produced from rice and wheat bran with levels (1.0, 1.5 and 2.0 %) as fat replacer decreased significantly ($p \leq 0.05$) with increasing of replacement level of CMC. These result agree with, Gok *et al.* (2011).



a: Pure cellulose
b: Commercial carboxymethyl cellulose
c: Carboxymethyl cellulose produced from rice bran
d: Carboxymethyl cellulose produced from wheat bran

On the other hand, protein content of the fat-replaced uncooked and cooked beef burger were increased as the replacement level increased. Furthermore, protein content percentage of uncooked beef burger samples were42.55, 44.14, 45.26and46.26% for control sample and those formulated by replace fat with levels (1.0, 1.5 and 2.0 %) CMC_1 produced from rice bran, respectively. Meanwhile, protein content percentage of uncooked beef burger samples containing CMC_2 produced from wheat bran were44.10, 45. 42 and46.41 respectively.

Crude fiber content was affected by fat replacement. Furthermore, it was significantly ($P<0.05$) increased by increasing fat replacement levels of CMC_1 and CMC_2. This increment may be due to high crude
fiber content of CMC_1 and CMC_2. Data of the present study are in agreement with those found by Youssef *et al*. (2012) and Gibis *et al*. (2017).

From the same Table (3) it could be noticed that, as the ratios of fat replacers increased the total carbohydrates of samples were increased with a significant difference in comparison with control beef burger.

Meanwhile, ash content in beef burger formula, it was, no significant differences at $p>0.05$. Also, from the same table, it should be noted that, cooked beef burger have percentages of moisture, ether extract and protein lower than uncooked beef burger with significant differences ($p \leq 0.05$) between samples. Meanwhile, the opposite were found in case of ash and crude fiber and total carbohydrate increased this also was probably due to the moisture loss during cooking (Essa and Elsebaie, 2018).

3.5. Effect of replacing fat with different levels of CMC produced from rice and wheat bran on physical properties and feder value

Data in Table (4) showed the physical properties of beef burger containing CMC produced from rice and wheat bran with level (1.0,1.5 and 2.0%) and control beef burger namely texture index Water Holding Capacity(WHC); Protein-Water Coefficient(PWC), Protein-Water-Fat Coefficient(PWFC)and feder value. The water holding capacity (WHC) of meat products is a very important quality attribute which has an influence on product yield, which in turn has economic implications, but is also important in terms of eating quality. (Chang and Sun, 2008).

From the same table, it could be observed that water holding capacity (WHC) of uncooked beef burger increased by increasing CMC produced from rice and wheat bran with level (1.0,1.5 and 2.0%).

WHC values of beef burger prepared with CMC produced from rice and wheat bran at different levels ranged from 59.28to 66.24% compared to 56.47% for control beef burger, this result is probably due to its ability to absorb large amounts of water. Similarly, (Gibis *et al.*(2015) , Basati and Hosseini(2018) and Guedes-Oliveira *et al.*(2019) they reported that , the increase in WHC in beef burger containing xanthan gums and carboxymethyl cellulose gums was due to the ability of a meat system to hold water is dependent of the strength of the protein network developed and the capacity of the hydrocolloid to entrap water within it, and the CMC is an anionic water- soluble polymer, which likely interacts with meat proteins.

Generally, The values of protein water coefficient (PWC) and protein water fat coefficient (PWFC) which are considered as indices for tenderness of the prepared beef burger, was given in the same Table, (4).

Table 4: Effect of replacing fat with different levels of carboxymethyl cellulose produced from rice and wheat bran on physical properties and feder value of beef burger formula.

Treatments		WHC %	Plasticity cm^2	PWC	PWFC	Feder Value
Control		56.47±0.14^d	6.34±0.03^a	0.312d±0.008	0.230d±0.006	2.48c±0.065
CMC$_1$	**1.0**	59.80±0.09^c	5.59±0.10^b	0.326c±0.006	0.241c±0.005	2.62b±0.040
	1.5	62.97±0.22^b	4.44±0.14^c	0.331b±0.008	0.252b±0.007	2.63b±0.078
	2.0	66.24±0.14^a	3.41±0.13^d	0.345a±0.006	0.260a±0.002	2.71a±0.083
CMC$_2$	**1.0**	59.28±0.10^c	5.49±0.13^b	0.322c±0.006	0.239c±0.008	2.61b±0.057
	1.5	62.39±0.16^b	4.45±0.15^c	0.330b±0.005	0.248b±0.007	2.62b±0.031
	2.0	65.87±0.14^a	3.44±0.19^d	0.341a±0.009	0.255a±0.008	2.70a±0.093

WHC= Water Holding Capacity; PWC= Protein-Water Coefficient; PWFC= Protein-Water-Fat Coefficient;
Each value is an average of three determinations ± standard division
Values followed by the same letter in columns are not significantly different at $P<0.05$
CMC$_1$, CMC$_2$are shown in table (A)

The results show that, the values of PWC and PWFC increased gradually with the increasing of CMC produced from rice and wheat bran with level (1.0, 1.5 and 2.0%) comparing to control sample. These results were in agreement with those published by Hassan *et al.* (2014). Also, it can be observed that, plasticity (cm^2) value of beef burger enriched with different levels of CMC is decreased gradually with increasing the replacement level of CMC. These results were in agreement with those published Shalaby *et al.*, (2015). Also, Feder values, which is used for assessing the physical properties of meat products, was 2.48 for control sample of burger. Feder values of burger increased gradually with increasing the replacement level of CMC. All values of feder values were kept under 4.0. According to Pearson (1991), the feder number in good quality product should not exceed 4.0. These increments in feder number may be due to the increase in water content as a result to increase the fiber content.

3.6. Effect of replacing fat with different levels of carboxymethyl cellulose produced from rice and wheat bran on cooking properties and pH value.

Regarding cooking measurements (cooking shrinkage, Diameter reduction, cooking yield and cooking loss) which are considered to be one of the most important physical quality changes occurring in beef burger during cooking processes, due to protein denaturation and release of fat and water from beef burger (Oroszvári *et al.*, 2005).

According to the data in Table (5). There were significant differences (P<0.05) between beef burger control and all low fat beef burger formulas prepared with carboxymethyl cellulose obtained from rice and wheat bran for cooking properties.

Apparent also from the same Table that, cooking loss of beef burger enriched with different levels of CMC_1andCMC_2 decreased with increasing the addition levels since beef burger enriched with CMC had cooking loss values lower than that of control. The highest value of cooking loss was observed with beef burger control (24.96%) while, the lowest value observed with low beef burger containing 2.0 % CMC_1 produced from rice bran (16.98%). This may be related to the fiber content of CMC_1 which could influence the cooking loss of the beef burger, since fibers could reduce the water loss during cooking by forming gels as reported by these results are in agreement with those of Gibis *et al.* (2015).

From the results in this Table, it could be noticed that, cooking yield of beef burger enriched with different levels of CMC_1 and CMC_2 is increased with increasing the addition levels, since beef burger enriched with CMC had cooking yield values higher than that of control.

Burger containing 2.0 % CMC_1 and CMC_2had the highest cooking yield values while, control had the lowest value. This may be related to the fibers content of CMC which could influence the cooking yield of the beef burger, since fibers could reduce the water loss during cooking by forming gels as reported by Han *et al*., (2018)

Preventing shrinkage considers as one of the most important factors to maintaining the quality levels of burgers because some consumers related to shrinkage and adding a high amount of water. Control beef burger sample had a high percentage of shrinkage and diameter reduction percent after cooking process in a comparison with burger integrated with CMC. These results are in conformity with the finding stated by Gibis *et al*. (2015) and Guedes-Oliveira *et al*..(2019)

Table 5: Effect of replacing fat with different levels of carboxymethyl cellulose produced from rice and wheat bran on cooking properties and pH value.

Treatments		% Cooking Loss	% Cooking yield	Shrinkage %	% Diameterreduction	pH
Control		24.96±0.14^{a}	75.04±0.11^{a}	19.90±0.11^{a}	16.84±0.10^{a}	5.85±0.16^{a}
	1.0	20.71±0.18^{bc}	79.29±0.15^{c}	14.35±0.16^{b}	13.38±0.11^{b}	5.70±0.13^{a}
CMC_1	**1.5**	18.43±0.12^{d}	81.57±0.13^{b}	12.70±0.09^{c}	12.55±0.14^{c}	5.63±0.10^{a}
	2.0	16.98±0.11^{e}	83.02±0.16^{ab}	11.50±0.11^{d}	11.16±0.19^{d}	5.61±0.12^{a}
	1.0	20.97±0.16^{bc}	79.03±0.12^{c}	14.39±0.18^{b}	13.44±0.13^{b}	5.77±0.10^{a}
CMC_3	**1.5**	18.73±0.13^{c}	81.27±0.13^{b}	13.00±0.10^{c}	12.60±0.19^{c}	5.69±0.15^{a}
	2.0	17.05±0.11^{d}	82.95±0.19^{ab}	11.58±0.14^{d}	11.48±0.15^{d}	5.49±0.14^{a}

Each value is an average of three determinations ± standard deviation
Values followed by the same letter in columns are not significantly different at P<0.05
CMC_1 and $CMC_1$are shown in table (A)

The beef burger control had highest values of shrinkage, diameter reduction and cooking loss (19.90, 16.84 and 24.96 % respectively). On the other hand, using CMC_1andCMC_2 at different levels improved the shrinkage, diameter reduction and cooking loss of low fat beef burger in compare with those of high fat beef burger control. These results are in harmony with those of (Gibis *et al.* (2015) they reported that, less shrinkage, diameter reduction and cooking loss in low-fat lamb patties containing CMC compared with control beef burger. Measuring of pH value is important due to its effect on several properties of meat products, for example color, shelf-life, texture and water holding capacity (Hashem *et al*.,2011). Apparent also from the same table that, no significant differences were noticed in pH among beef burger control (5.85) and that formulated with different replacement levels of CMC. These results are similar to those reported by Aleson-Carbonell *et al.*, (2005).

3.7. Effect of replacing fat with different levels of carboxymethyl cellulose produced from rice and wheat bran on Texture Profile Analysis (TPA)

In the present study, the results of beef burger containing CMC produced from rice and wheat bran with levels (1.0, 1.5 and 2.0%) and control beef burger were determined as Hardness, springiness, gumminess, chewiness, and cohesiveness values are presented in Table (6).

Results showed that, Hardness, cohesiveness, springiness, gumminess, and chewiness values of cooked beef burger significantly at (P>0.05) decreased with increasing levels CMC produced from rice and wheat bran. The highest values were noticed in control sample (18.65, 0.47, 0.73, 8.83 and 6.41 respectively) while, lowest values was noticed in cooked beef burger containing 2.0 % CMC produced from wheat bran (17.33 , 0.37 ,0.60, 6.41and 3.85 respectively) compared to all samples the same trend was reported by Han and Bertram (2017)and Guedes-Oliveira *et al*.(2019). The decrease in hardness may be ascribed to a destabilization of the batter with the addition of CMC and pectin, which upon heating therefore no longer is converted into a coherent protein network (Schuh *et al*., 2013 and Gibis *et al.,* 2015).

Table 6: Effect of replacing fat with different levels of carboxymethyl cellulose produced from rice and wheat bran on Texture Profile Analysis (TPA)

Treatments		Hardness (N/cm2)	Coh (ratio)	Spr (cm)	Gum (N/cm2)	Che (N/cm2)
Control		18.65±0.34^{a}	0.47±0.07^{a}	0.73±0.16^{a}	8.83±0.10a	6.41±0.42a
CMC_1	**1.0**	18.50±0.21ab	0.42±0.09ab	0.72±0.04^{a}	7.95±0.33b	5.80±0.14b
	1.5	17.86±0.39^{b}	0.41±0.09^{ab}	0.68±0.01^{ab}	7.31±0.26c	4.99±0.25c
	2.0	17.41±0.36^{bc}	0.38±0.06^{b}	0.60±0.03^{c}	6.58±0.10d	3.96±0.31d
CMC_2	**1.0**	18.41±0.29ab	0.42±0.01^{ab}	0.71±0.04^{ab}	7.73±0.14b	5.49±0.10b
	1.5	17.80±0.11^{b}	0.39±0.03^{b}	0.66±0.01^{b}	6.88±0.18c	4.59±0.34c
	2.0	17.33±0.13^{c}	0.37±0.01^{b}	0.60±0.02^{c}	6.41±0.19d	3.85±0.36d

Coh= Cohesiveness; Gum= Gumminess; Che= Chewiness; Spr= Springiness
Each value is an average of three determinations ± standard deviation
Values followed by the same letter in columns are not significantly different at P<0.05
$CMC_1$and$CMC_2$are shown in table (A)

3.8. Sensory evaluation of beef burger containing CMC produced from rice and wheat bran with levels (1.0, 1.5 and 2.0%) and control beef burger

Sensory properties of any food product are the major part of important attributes that affect the consumer choice (Salem, 2013).

Sensory properties of beef burger as affected by replacing fat with containing CMC produced from rice and wheat bran with levels (1.0,1.5 and 2.0%) and control beef burger are shown in Table (7).

Table 7: Effect of replacing fat with different levels of carboxymethyl cellulose extracted from rice and wheat bran on Sensory evaluation.

Treatment		Color (10)	Taste (10)	Odour (10)	Texture (10)	Appearance (10)	Overall Acceptability (10)
Control		8.80a ±0.36	8.90a±0.55	9.0a±0.60	8.7a±0.52	8.8a±0.38	9.0a±0.47
CMC_1	**1.0**	8.62b ±0.32	8.85a±0.67	8.80a±0.55	8.53a±0.33	8.55a±0.51	8.82a±0.29
	1.5	8.24bc±0.30	8.67a±0.49	8.61a±0.34	8.51a±0.52	8.52a±0.67	8.63a±0.43
	2.0	8.09c ±0.25	8.60a±0.48	8.52a±0.37	8.42a±0.40	8.42a±0.42	8.55a±0.57
CMC_2	**1.0**	8.60b ±0.35	8.70a±0.59	8.65a±0.39	8.55a±0.45	8.55a±0.36	8.71a±0.39
	1.5	8.20bc 0.23	8.50a±0.40	8.50a±0.36	8.40a±0.53	8.41a±0.41	8.52a±0.68
	2.0	8.08c ±0.24	8.45a±0.32	8.45a±0.76	8.40a±0.47	8.4a±0.49	8.50a±0.71

Each value is an average of three determinations ± standard division
Values followed by the same letter in columns are not significantly different at P<0.05
CMC1and CMC2 are shown in table (A)

From statistical analysis of these data, it could be noticed that there were no significant difference at (P<0.05) in all sensory properties between all beef burger formula except color had a significant at (p≤0.05) increased with increasing levels CMC produced from rice and wheat bran. The highest values were noticed in control beef burger (8.80) while , lowest values was noticed in cooked beef burger at 2.0 % level CMC produced from wheat bran (8.08) compared to all samples This result was agreements with Hassan *et al*.(2014). Moreover, all beef burger formula containing CMC obtained from rice milling by-products produced acceptable samples compared with the control . Ramadan *et al*. (2016) reported that the cereal fiber is neutral in taste and help to retain moisture and fat leading to producing of a more succulent and juicy meat product.

4. Conclusion and Recommendations

- Rice and wheat bran is a cheap and new source of carboxymethyl cellulose production
- Carboxymethyl cellulose produced from rice and wheat bran have phychemical properties that represent the industrial carboxymethyl cellulose.
- Carboxymethyl cellulose, produced from rice and wheat bran improves physical , chemical, cooking and sensory properties of burger.

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