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QUALITY ATTRIBUITES OF LOW – FAT BEEF SAUSAGE CONTAINING DIFFERENT DIETARY FIBERS

BY

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ABSTRACT

Dehydrated cabbage leafstalks, artichoke leaves and peanut hulls as by-product of food processing were added as sources of dietary fibers at four levels (5, 10, 15 and 20 %) to beef sausage instead of fat and evaluated for chemical, physical and sensory traits. Beef sausage formulated with dietary fibers were significantly higher ($p<0.1$) in moisture, protein, ash and carbohydrate and lower ($p<0.1$) in fat than that of control sample. The addition of different dietary fibers significantly reduced the fat content of beef sausage by about 24.74 to 39.83 %. Beef sausage containing 10% of artichoke leaves and 5% of peanut hulls had cooking losses of 8.17 and 13.60 %, respectively, less than of control (15.69 %). The cooking yield of beef sausage were significantly ($p<0.1$) improved by addition of dietary fibers, for example, cooking yield of beef sausage samples containing 5 and 10 % of artichoke leaves were 90.53 % and 91.39 % compared to 84.27% for control sample. Beef sausage samples, contained different tested dietary fibers recorded higher significant plasticity than control sample at zero time and during frozen storage for 90 days. WHC values (cm^2 / 0.3 g sample) showed a pattern similar to that of plasticity. Addition of the tested dietary fibers has lowered significantly hardness values of the uncooked and cooked sausage than control sample. Frozen storage has generally increased hardness value of both raw and cooked sausage samples. Sausage prepared with 5 and 10 % of dietary fiber sources exhibited significantly less change in sensory traits during frozen storage. Later on, dehydrated dietary fiber sources can be used successfully as a fat substitute in beef sausage.

Key word: Beef sausage- Cabbage leafstalks- Artichoke leaves-Peanut hulls-Dietary fiber- Physical and sensory properties.

INTRODUCTION

Dietary fiber is a group of food components which is resistant to hydrolysis by human digestive enzymes and necessary for promoting good health. It is classified into 2 groups by means of its solubility in water as soluble and insoluble dietary fiber. The main components of dietary fibers are cellulose and lignin, but also the hemicelluloses, pectin, gums, and other carbohydrates not digestible by human digestive tract. Cellulose is a kind of insoluble dietary fiber, consisting of units of glucose with β-1, 4 linkages. Dietary fiber is the food fraction that is not enzymatically degraded within the human alimentary digestive tract. (Stear, 1990 and Prakongpan *et al.*, 2002)).

The importance of the dietary fiber is increasing due to its beneficial effects on the reduction of cholesterol levels and the risk of colon cancer (Anderson, 1991 and Levarate Verny *et al.*, 1999). Recommendations such as those set forth by the American Heart Association, to reduce dietary fat intake to lower serum cholesterol levels may have led to an increase in the consumption of low fat (<20 %) ground beef over that of regular (30 % fat) ground beef (Hoelscher *et al.*, 1987 and Torre *et al.*, 1995). High fiber, low fat foods tend to reduce risk of colon cancer, obesity, cardiovascular diseases and several other disorders (NCI, 1984 and Claye *et al.*, 1998). Furthermore, it has been proposed that some soluble fibers bind toxic compounds as a protective mechanism of the fibers against gastrointestinal cancers (Schneeman, 1986). Dietary fiber also is one of the most common functional ingredient in food products and has been used as fat replace, fat reducing agent during frying, volume enhancer, binder, bulking agent and stabilizer. (Ang and Miller, 1991). It is frequently used in bakery products, deep fat fried foods and meat patties. In developing new products, differences in fiber solubility are considered to select suitable fiber ingredients accordingly (Ranhotra and Gelroth, 1985). The factors to be considered in utilization of fiber ingredients are color, flavor, and particle size (Ranhotra *et al.*, 1990). High fiber products are necessary ingredients for foods, in addition to fiber enrichment, a reduction of caloric content is required. In that case, the fiber material serves also as a bulking ingredient. The source of fiber is also important because various arrays of plant cells can affect fiber properties. Several sources of dietary fiber such as purified cellulose, wheat bran and pea hulls have been incorporated into food products as fiber supplements. (Sosulski and Cadden, 1982). In addition, peanut hulls have extensively evaluated as a potential fiber additive. Also, several crops are currently being grown in the upper Midwest of USA (flax, mustard and sunflower) which have hulls high in potential food grade dietary fiber. Cauliflower is a pectic polysaccharide rich fiber source which is economically important, but as a fresh vegetable less 40 % of the available plant is used. The low natural pigmentation in cauliflower also makes it more adaptable and acceptable as an ingredient in processed foods. (Femenia *et al.*, 1997). Several studies were done to retain sensory and textural attributes through fat reduction by replacing fat with water (Ahmed *et al.*, 1990) water and phosphate (Miller *et al.*, 1993) carbohydrate and protein based on fat substitutes (Carballo *et al.*, 1995) and vegetable gums (Trius *et al.*, 1994). Fiber supplements used in food come mainly from processing by products, e.g. wheat bran, corn hull, soy hull, rice bran, apple pomace and sugar beet pulp, or are texturizing agents, e. g. carrageenan. The source of fiber supplement can affect the dietary response since the matrix structure rather than isolated components are more effective (Wolever, 1990, Idouraine, 1996, Khalon and Chow, 2000).

To the best of our knowledge there are no reports on the use of, cabbage leafstalks, artichoke leaves and peanut hull fibers as a fat replacement in meat products. Therefore, the objectives of this study were to determine the physico-chemical characterization of flours prepared from the three dietary fiber sources and to study the effect of adding them at different levels as a fat replace on the quality attributes of low fat beef sausage.

MATERIALS AND METHODS

Preparation of dietary fiber flour:-

Fresh cabbage leaf stalks (*Brassica oleracea ver. Capitata*) and artichoke leaves (*Cynare scolymus*) were obtained from local market in one batch, washed in fresh water then dissected into equal length and dried in a forced air oven at 75^{0}c for 24 hr. The flour was prepared by finely ground three times using a high speed laboratory grinding mill to pass through 0.5 *mm*. sieve. (Femenia, *et al*., 1997). Hulls of peanut (*Arachis hypogaea*) were obtained from local market, the larger pieces of hull were separated from the debris then the hulls were washed in a solution of sodium dodecyl sulfate (17CC dry detergent per 38L. Water) rinsed three times in fresh water and dried in a forced air oven at 85^{0}C for 24 hr .Apportion of the hulls were toasted at 149^{0}C for 1 hr, then the hulls were finely ground to pass through 0.5 mm. sieve, (Collins and Post, 1981).

Beef sausage manufacture:-

Beef sausage was prepared according to the method described by Zaika *et al*. (1978). The frozen meat and fat were ground by the house grinder, and then sausage was prepared by blending the 1.2% of spices mixture with the following ingredients for 3 min.

Lean	70.0 g
Fat tissues	12.0g
Sodium chloride	2.3g
Water (as ice)	9.295g
Starch	3.0g
Spices mixture*	1.2g
Sodium nitrite	0.005g
Garlic	1.0g
Onion	1.2g
*Spices mixture	
Black pepper	30.0g
Nut meg	8.0g
All spices	15.0g
Red pepper	8.0g
Cloves	8.0g
Cinnamon	15.0g
Ginger	8.0g
Coriander	8.0g

Meat mixture was stuffed into mutton casings, the casings were then closed and chipped (Shehata, 1989). Natural mutton casings were obtained from the slaughtered animal and prepared according to El-Deep, (1987)

To evaluate the effects of the investigated dietary fiber flours on sausage quality, substitution of fat in the basic formula of sausage with a 5, 10, 15 and 20 % level of the different prepared fiber flour was applied.

Different sausage samples were packaged in polyethylene bags and stored at – 18 ^{0}C for 3 months until analysis.

Proximate composition:-

Moisture, fat, crude protein (Nx6.25) and ash of different samples were determined according to AOAC (1990) procedure .Total carbohydrate contents were calculated by difference. The percentage of total dietary fiber was determined by an enzymatic gravimetric method (Prosky *et al.*, 1988). All determinations were prepared in triplicate.

Physical properties:-

Bulk density:

Fifty ml of a preweighed graduate cylinder was filled with flour sample and shaken slightly. The volume of the sample was recorded, the content of the cylinder was weighed and the bulk density was expressed as weight per volume, (Prakongpan *et al.*, 2002).

Packed density:

A calibrated 10 ml graduated syringe was filled with a known weight of flour sample. Pressure was applied manually until additional pressure would not further reduce the volume. The packed density was calculated as weight of sample per least volume of sample, (Prakongpan *et al.*, 2002)

Hydrated density:

A calibrated 10 ml graduate cylinder was filled with a known amount of distilled water, and a known weight of sample was added carefully to avoid adhesion to cylinder walls. The difference between the volume of the water before and after adding sample was recorded as ml of water displaced .Results were expressed as grams of sample per ml .of water displaced, (Prakongpan *et al*, 2002)

Swelling:

Swelling was measured as bed volume after equilibration in excess solvent (Kuniak and Marchessauult, 1972). Sample (0.5-1.0g) was weighed into a 15 ml graduated conical tube. Ten ml of the phosphate buffer was added and the suspension was stirred. After equilibration (16 hr) the volume was recorded and expressed as ml/g dry sample.

Water and oil retention capacity:

The water and oil retention capacity of the different flour samples was determined following the method described by Ang (1991). By using a glass rod. 2 g of sample was mixed with 30 ml of distilled water in a 50 ml centrifuge tube. The slurry was allowed to stand for overnight, then centrifuge at 2000 xg for 15 min. After centrifugation the supernatant was drained and the wet sample precipitate was weighed. The result was expressed as gram of water per gram of sample. The same procedure was applied to determine the oil retention capacity except that corn oil was used instead of water

Solubility:

Solubility was measured in conjunction with water retention capacity, as % loss in the original sample dry weight after recovery of insoluble material used to determine water retention capacity. (Femenia *et al* . 1997)

pH:

pH of a mixture of 1 g flour and 50 ml distilled water was measured on a pH meter, (Jenway 3310, England) according to Collins and Post, 1981

Emulsifying capacity and emulsion stability:

Emulsifying activity (EA) was determined according to Pearce and Kinsella (1978). Corn oil and aqueous flour solutions were homogenized by Virtis homogenizer (Model 6-105 AF) at 10, 000 rpm for 60 sec A sample of 0.1 ml was immediately taken from the bottom of the container and diluted to 50 ml with 0.1 % sodiumdodecyl sulfate (SDS)

The absorbance of the diluted emulsion was determined at 500 nm The initial A500 measurement was taken to be the emulsification activity, while emulsion stability (ES) was measured the A 500 after heating the prepared emulsions at 80 ^{0}c for 30 min, cooled at room temperature and the absorbance was measured

Viscosity:

The apparent viscosity of 2% suspension of different flour samples was measured using the Brookfield digital viscometer at speed 60 rpm according to Prakongpan *et al.* (2002)

Water holding capacity

The method of Volovinskaia and Merkoolova (1958) was used to measure the water holding capacity and plasticity of different sausage samples Sausage sample (0.3 g) was placed on filter paper (Whatman No.1) which was placed between two glass sheets and pressed for 10 min with a 1 Kg standard weight. Two zones were measured using planimeter the outer zone represented the WHC where the internal zone represented the plasticity Results were presented in cm ^{2} per 0.3 g sample

Cooking method:

The sausage samples were grilled in preheated oven at 163 ^{0}Cfor 10 min .to produce uniform browning without charring as described by Baker *et al.* (1984). The beef sausage samples were weight before and after cooking to determine percentage of cooking loss and cooking yield as follows:

$$\% \text{ Cooking loss} = \frac{\text{Raw weight - Cooked weight}}{\text{Raw weight}} \times 100$$

$$\% \text{ Cooking yield} = \frac{\text{Cooking weight}}{\text{Raw weight}} \times 100$$

Hardness:

Hardness of sausage samples was determined according to Sanderson, *et al.* (1988), by measuring Tension Compression (TC^2). An anvil of 1 mm diameter was used to penetrate the sample at a crosshead speed of 500 mm/ min. The result was calculated as g/ cm ^{2}.

Sensory analysis:

Cooked sausage samples were assessed for their quality attributes by ten panelists according to Klein and Bardy (1984). Panelists were asked to score the different sausage samples for appearance, color, aroma, taste, juiciness, tenderness and overall acceptability, as follows: very good 8-9, good 6-7, fair 4-5 poor 2-3 and very poor 2-1.

Statistical analysis:

The statistical analysis system (SAS, 1996) was used to carry out mean values, standard errors in addition to an over all analysis of variance (ANOVA) and least significant differences (LSD) at 0.01.

RESULTS AND DISCUSSION

Proximate chemical composition of different dietary fiber sources:-

The proximate analysis of the flours prepared from cabbage leafstalks, artichoke leaves and peanut hulls are shown in Table (1). The three dietary fiber sources are different significantly ($p<0.01$) for moisture, ash, dietary fiber and total carbohydrate contents. The flour of artichoke leaves was found to have a higher dietary fiber content (63.66%) followed by peanut hull (48.09%) and cabbage leafstalks (36.77%) flours. Artichoke leaves also had higher protein and ether extract content than cabbage leafstalks and peanut hull. However, cabbage leafstalks contained relatively high amount of ash and moisture. On the other hand peanut hulls showed higher value of total carbohydrates. All above results are found to be closely near for those obtained by Collins and post (1981) Hegazy *et al.* (1991) and Femenia *et al.* (1997).

Table (1): Proximate analysis of flours of different dietary fiber sources (dry weight basis)

Fiber source	Moisture Content %	Protein Content %	Ether extract %	Ash Content %	Total dietary fiber Content %	Total carbohydrate* Content %
Cabbage leafstalks	9.19 ^{a}	6.79 ^{b}	0.95 ^{b}	13.53 ^{a}	36.77 ^{c}	41.96 ^{b}
Artichoke leaves	8.72 ^{b}	8.12 ^{a}	4.80 ^{a}	5.98 ^{b}	63.66 ^{a}	17.44 ^{c}
Peanut hull	5.66 ^{c}	6.26 ^{b}	1.32 ^{b}	2.16 ^{c}	48.09 ^{b}	42.17 ^{a}

*- Total carbohydrate was calculated by difference

a.b .Means in the same column with different superscript letters are significantly different ($p < 0.01$)

Physical and functional properties of different dietary fiber sources:-

Bulk, hydrated and packed densities of the three different dietary fiber sources are shown in Table (2). Normally, the bulk density of the fibers depends on their shape and size. Cabbage leafstalks flours showed higher bulk and packed density than artichoke leaves and peanut hulls. No significant differences ($p<0.01$) were observed for packed and hydrated density between artichoke leaves and peanut hulls. Swelling values for different dried fibers are ranged from 4.57 to 7.87 ml/g dry weight. The characteristics of fibers in imbibing and swelling in water are important not only in food application, but, also in human gastrointestinal function (Stephen, 1995 and Prakongpan *et al*., 2002) Water and oil retention capacity of different fiber sources were determined and their results are shown in Table (2) as g of water or oil retained per g of dry sample. Overall, it was found that artichoke leaves could retain more water than other fibers, but, peanut hulls could hold the highest amount of oil. No significant difference ($p<0.01$) was observed in water retention capacity values between cabbage leafstalks and peanut hulls. The mechanism of oil adsorption is unknown (Thibault *et al*., 1992) but Fleury and Lahaya (1991) suggested that surface properties overall charge density and the hydrophobic nature of particles could be important for incorporation of fibers into foods. All tested fibers are hydrophilic so they could retain large amount of water than oil. Results also, showed that the flour of cabbage leafstalks were more soluble (37.39%) in water than the other two fiber sources. The influence of the tested fibers on the oil weight required to form emulsion are given in the same Table. Results showed that addition of different sources of fibers reduced the oil weight required to form emulsion especially for cabbage leafstalks (0.068 g oil) followed by artichoke leafs and peanut hull (0.253 and 0.271 g oil, respectively) Similar results are obtained by Collins and post (1981). The highest viscosity of fiber suspension was obtained for artichoke leaves (3.20 cps). Generally, the difference between emulsion capacity, stability and viscosity values of artichoke leaves and peanut hulls were not significant ($p<0.01$). pH values of fiber suspension was ranged between 6.18 and 6.52

Functional properties, i.e. water retention capacity (WRC) solubility and emulsifying capacity and stability were measurable under different pH values of dispersion for all fiber samples and the results are given in Table (3). There were significant differences for functional properties of different dietary fiber sources as a function of using different pH values. The highest WRC values could be arranged in a descending order as follows, 12.42 g water/g artichoke leaves at pH1.5, 6.69 g water/ g cabbage leafstalks at pH 3.0 and 5.73 g water/g peanut hull at pH 4.5. For solubility, the studied samples could be arranged in a descending order as follows: cabbage leafstalks (46.83 at pH 1.5) peanut hulls (12.27 at pH 4.5) and artichoke leaves (9.76 at natural pH). Such behavior could be attributed to the soluble fractions of dietary fiber in which the swelling power increased as the soluble fraction increased (Galal, 1998). The maximal emulsifying capacity and stability was recorded at pH 9.0 for the three dietary fiber samples. Peanut hulls has the highest value for EC and ES (0.378 and 0.299 g/g sample) followed by artichoke leafs (0.264 and 0.196 g/ g sample) and finally cabbage leafstalks (0.245 and 0.134 g /g sample). The high value of EC and ES of peanut hulls flour may due to the large proportion of lignin reported by Collins and Post (1981) and the obtained results of EC and ES are in agreement with those ranges reported by Galal (1998).

Therefore, using different dietary fiber sources as a fat replacer at different levels was applied to produce high quality low fat beef-sausage.

Sensory evaluation of cooked sausage with different dietary fiber sources:-

The effect of substitution of sausage fat with 4 fibers level (5-20%) and 3 types of fibers (cabbage leaf stalks, artichoke leaves and peanut hull) on sensory properties of cooked beef-sausage are shown in Table (4). Results showed that substitution of sausage fat with 5 and 10% of different dietary fiber sources received significantly higher scores ($p<0.01$) than control samples and those contained 15 and 20% of dietary fibers for all sensory properties. Also, samples containing higher level of fiber sources (15 and 20%) were received lower scores than control samples. Comparison of sensory properties of cooked beef sausage samples containing 5 and 10% of different dietary fibers, showed that sausage sample prepared with artichoke leaves recorded higher scores followed by cabbage leaves and peanut hulls. Also, sausage formulated with 5 and 10 % levels of 3 types of fibers were significantly ($p<0.01$) more tender and juicy than that of containing 15 and 20 % levels in addition to the control sample. Similar results were obtained by Meullenet, *et al* (1994) who reported that juiciness of chicken frankfurters was decreased as collagen fiber increased.

Therefore, substitution of sausage fat with 5 and 10% of different dietary fiber sources were selected to produce high quality low fat beef-sausage

Proximate chemical analysis of sausage made with selected concentration of dietary fibers:-

Chemical analysis of sausage containing selected concentration of different dietary fibers are listed in Table (5). Results showed that control beef

Table (2): Physical and functional properties of flours of different dietary fiber sources

Fiber source	Bulk density g/ml	Hydrated density g/ml	Packed density g/ml	Swelling ml/g	Water retention g water/g fiber	Oil retention g oil/g fiber	Solubility %	Emulsifying Capacity	Emulsifying Stability	Viscosity of fiber suspension (cps)	pH of Fiber suspension
Cabbage leafstalks	0.51^{a}	1.09^{b}	0.96^{a}	7.87^{a}	4.88^{b}	1.16^{c}	37.39^{a}	0.068^{b}	0.005^{b}	3.07^{a}	6.18^{b}
Artichoke leaves	0.26^{b}	2.17^{a}	0.52^{b}	7.07^{b}	9.89^{a}	2.78^{b}	9.76^{b}	0.253^{a}	0.179^{a}	3.20^{a}	6.48^{a}
Peanut hull	0.14^{c}	2.13^{a}	0.48^{b}	4.57^{c}	4.81^{b}	3.59^{a}	6.73^{c}	0.271^{a}	0.172^{a}	3.05^{a}	6.52^{a}

a.b Means in the same column with different superscript letters are significantly different ($p < 0.01$)

Table (3): Functional properties of flours of different dietary fiber sources as affected by pH value

pH value	Cabbage leafstalks fiber				Artichoke leaves fiber				Peanut hull fiber			
	Water retention g water/g fiber	Solubility %	Emulsifying capacity	Emulsifying stability	Water retention g water/g fiber	Solubility %	Emulsifying capacity	Emulsifying stability	Water retention g water/g fiber	Solubility %	Emulsifying capacity	Emulsifying stability
1.5	6.28^{a}	46.83^{a}	0.079^{d}	0.045^{c}	12.42^{a}	7.93^{b}	0.058^{c}	0.028^{c}	4.83^{c}	11.77^{b}	0.096^{d}	0.018^{c}
3.0	6.69^{a}	36.63^{c}	0.080^{d}	0.040^{c}	12.18^{a}	6.83^{d}	0.067^{c}	0.049^{c}	5.33^{ab}	9.90^{d}	0.284^{b}	0.016^{c}
4.5	5.75^{b}	35.33^{d}	0.079^{d}	0.018^{d}	11.86^{ab}	6.52^{d}	0.080^{c}	0.046^{c}	5.73^{a}	12.27^{a}	0.154^{c}	0.043^{c}
6.0	4.54^{c}	33.30^{f}	0.108^{c}	0.080^{b}	9.89^{c}	5.93^{e}	0.231^{b}	0.093^{b}	4.64^{c}	11.27^{c}	0.141^{c}	0.069^{c}
7.5	6.41^{a}	34.00^{e}	0.187^{b}	0.124^{a}	11.57^{b}	7.37^{c}	0.243^{ab}	0.184^{a}	4.86^{cb}	10.12^{d}	0.145^{c}	0.150^{b}
9.0	6.31^{a}	34.73^{de}	0.245^{a}	0.134^{a}	11.78^{b}	7.40^{c}	0.264^{a}	0.196^{a}	3.51^{d}	9.57^{d}	0.378^{a}	0.299^{a}
original pH	4.88^{c}	37.39^{b}	0.068^{d}	0.005^{d}	9.89^{c}	9.76^{a}	0.253^{a}	0.179^{a}	4.81^{c}	$.73^{e}$	0.271^{b}	0.172^{b}

a.b Means in the same column with different superscript letters are significantly different ($p < 0.01$)

sausage (without dietary fibers) contained less moisture, protein, ash and carbohydrate contents (60.38, 62.26, 4.15 and 9.49 %, respectively) and more fat contents (24.13 %) than other tested samples (with dietary fibers), which contained moisture, protein, ash and carbohydrate contents in the range of 61.44 to 66.94 %, 62.68 to 66.81 %, 4.46 to 9.29 % and 9.92 to 16.46 %, respectively. Fat content of experimental samples ranged from 14.52 to 18.16 %. Replacement of sausage fat with different levels of dietary fibers resulted in significant ($p<0.01$) differences in fat content of uncooked beef-sausage (Table 5). Fat content of uncooked beef-sausage significantly ($p<0.01$) decreased as level of dietary fibers increased, these results are coincided with that of Mansour and Khalil, (1997). Percentage reductions in fat content of uncooked beef-sausage contained 5% of different dietary fiber sources ranged from 24.74 to 26.15%. While percentage reductions in fat content of uncooked beef-sausage contained 10% of different dietary fiber sources ranged from 37.12 to 39.29%. These results indicated that, the formulation of beef-sausage with selected percentages of different dietary fiber sources (5 and 10%) is considered an excellent method for fat reduction which is very important for consumers restricted for their fat intake.

Table (4): Sensory attributes of cooked beef sausage prepared with different level of dietary fibers

Level of fat substitution %	Mean values of sensory attributes						
	Appearance	Color	Aroma	Taste	Juiciness	Tenderness	Overall acceptability
			Cabbage leafstalks fiber				
(0%) Control	7.10^{c}	7.10^{c}	7.10^{c}	7.10^{c}	7.10^{c}	7.10^{d}	7.00^{d}
5 %	7.60^{b}	7.60^{c}	7.60^{b}	7.70^{b}	7.60^{b}	7.80^{b}	7.80^{b}
10 %	8.60^{a}	8.00^{a}	8.00^{b}	7.70^{b}	8.10^{a}	7.90^{b}	8.00^{ba}
15 %	5.10^{e}	5.10^{e}	5.10^{f}	5.10^{f}	5.20^{e}	5.20^{f}	5.10^{e}
20 %	5.10^{e}	5.10^{e}	5.10^{f}	5.10^{f}	5.20^{ed}	5.20^{f}	5.10^{e}
			Artichoke leaves fiber				
(0%) Control	7.10^{c}	7.10^{c}	7.10^{c}	7.10^{c}	7.10^{c}	7.10^{d}	7.00^{d}
5 %	8.40^{a}	8.30^{a}	8.40^{a}	8.20^{a}	8.30^{a}	8.30^{a}	8.40^{a}
10 %	8.40^{a}	8.30^{a}	8.40^{a}	8.20^{a}	8.30^{a}	8.40^{a}	8.30^{a}
15 %	5.80^{d}	5.70^{e}	5.70^{d}	5.70^{d}	5.80^{d}	5.80^{e}	5.60^{e}
20 %	5.80^{d}	5.70^{e}	5.60^{d}	5.60^{d}	5.70^{d}	5.70^{ef}	5.50^{e}
			Peanut hull fiber				
(0%) Control	7.10^{c}	7.10^{c}	7.10^{c}	7.10^{c}	7.10^{c}	7.10^{d}	7.00^{d}
5 %	7.60^{c}	7.60^{b}	7.60^{b}	7.60^{b}	7.70^{b}	7.70^{b}	7.70^{c}
10 %	7.50^{c}	7.70^{b}	7.60^{b}	7.50^{b}	7.60^{b}	7.50^{b}	7.50^{c}
15 %	5.10^{e}	5.20^{e}	5.20^{f}	5.20^{f}	5.40^{d}	5.40^{fe}	5.10^{e}
20 %	5.10^{e}	5.10^{ef}	5.00^{f}	5.00^{f}	5.20^{d}	5.20^{f}	5.00^{e}

a.b. ......Means in the same column for the same dietary fiber with different superscript letters are significantly different ($p < 0.01$)

Table (5): Chemical composition of raw beef sausage prepared with different dietary fiber sources (dry weight basis)

Dietary fiber % / Chemical analysis	Control	Cabbage leafstalks		Artichoke leaves		Peanut hull	
	0	5	10	5	10	5	10
Moisture content %	60.38^{e}	61.78^{d}	62.77^{c}	65.61^{b}	66.94^{a}	61.44^{d}	62.81^{c}
Protein content %	62.26^{f}	63.36^{d}	64.31^{c}	65.61^{b}	66.81^{a}	62.68^{e}	63.60^{d}
Ether extract %	24.13^{a}	17.65^{d}	14.52^{g}	18.16^{b}	15.15^{e}	17.82^{c}	14.65^{f}
Ash content %	4 15^{g}	8.46^{b}	9.29^{a}	6.32^{d}	7 49^{c}	4 46^{f}	5.29^{e}
Total carbohydrate content * %	9.49e	10.56^{d}	11.88^{c}	9 92^{e}	10.55^{d}	15.03^{b}	16.46^{a}

* Calculated by difference

a.b Means in the same row with different superscript letters are significantly different ($p < 0.01$)

Sensory evaluation of beef-sausage prepared with different fibers during frozen storage:-

Sensory attributes of sausage prepared with selected concentration of different fiber sources as affected by frozen storage are shown in Table (6) Generally. the results showed that sausage prepared with different fiber sources gave higher values than the control sample Also. the data showed that formulas contain artichoke leaves fiber gave higher values compared with cabbage leafstalks and peanut hull The results indicated that there no significant ($p<0.01$) differences between control sample and experimental sausage samples except. sausage prepared with artichoke leaves which showed higher significant ($p<0.01$) for most properties. It could be observed the positive effect of fiber sources for all attributes during storage for 90 days. Changes in attributes were much faster in control sample than experimental sausage. On the other hand. the results obtained indicated that experimental sausages were acceptable till storage for 3 months compared with the control sample which their scores decreased rapidly. Similar results were obtained by Troutt *et al* (1992) who reported that the control patties with 5-10% fat generally were more moist and juicy than other low fat patties formulated with anhydrate sugar beet. oat and pea fibers and their combinations with potato starch and polydextrose In side other. useful hamburger made using 20 % okra tempeh for improving the quality during processing and storage (Matsuo. 1995) Also Femenia *et al* (1997) stated the use of cauliflower floret\cured and stem as by products of processing to processed meats to improve texture In addition to. Gorecka. *et al* (2000). stated that sensory analysis of experimental foods with the addition of 5-10 % lupine meal or hull (shortcakes. gingerbread, pancakes and meat dumplings and meat mince) showed that lupine meal or hull could be successfully added at less than or equal 10 %

Table (6): Means values of sensory attributes of beef sausage prepared with different levels of dietary fiber sources as affected by frozen storage

Dietary fiber % / Storage period (days)	Control	Cabbage leafstalks		Artichoke leaves		Peanut hull	
	0	5	10	5	10	5	10
Appearance							
Zero	8.8^{Aba}	9.0^{Aa}	8.9^{ABa}	8.6^{ABa}	8.5^{ABa}	8.7^{ABa}	8.6^{ABa}
30	7.9^{Bb}	8.1^{Bb}	8.1^{Bb}	8.8^{Aa}	8.8^{Aa}	8.1^{Bb}	8.1^{Bb}
60	7.3^{Bc}	7.9^{Ab}	7.8^{Ab}	8.0^{Ab}	7.8^{Ab}	7.4^{Bc}	7.4^{Bc}
90	5.6^{Cd}	6.4^{ABc}	6.2^{ABc}	6.8^{Ac}	6.8^{Ab}	6.3^{Bd}	6.2^{Bd}
Color							
Zero	8.9^{Aa}	8.9^{Aa}	8.8^{Aa}	8.8^{Aa}	8.5^{Aa}	8.5^{Aa}	8.5^{Aa}
30	8.0^{Bb}	8.1^{Bb}	8.1^{Bb}	9.0^{Aa}	9.0^{Aa}	8.0^{Bb}	8.0^{Bb}
60	7.5^{Bc}	8.1^{Ab}	8.1^{Ab}	8.2^{Ab}	7.9^{Ab}	7.6^{Bb}	7.5^{Bb}
90	5.9^{Bd}	6.7^{Ac}	6.7^{Ac}	7.0^{Ac}	7.0^{Ac}	6.0^{Bc}	6.0^{Bc}
Aroma							
Zero	8.9^{Aa}	8.5^{Aa}	8.8^{Aa}	8.8^{Aa}	8.8^{Aa}	8.7^{Aa}	8.7^{Aa}
30	7.9^{Bb}	8.0^{Ba}	8.0^{Bb}	8.7^{Aa}	8.7^{Aa}	8.1^{Bb}	8.1^{Bb}
60	7.2^{Bc}	8.0^{Aa}	7.9^{Ab}	8.1^{Ab}	7.9^{Ab}	7.5^{ABc}	7.6^{ABc}
90	5.8^{Cd}	6.7^{Ab}	6.7^{Ac}	7.1^{Ac}	7.1^{Ac}	6.6^{ABd}	6.4^{Bd}
Taste							
Zero	8.8^{Aa}	8.5^{Aa}	8.5^{Aa}	8.6^{Aa}	8.6^{Aa}	8.6^{Aa}	8.5^{Aa}
30	7.8^{Bb}	8.1^{Ba}	8.1^{Bb}	8.5^{Aa}	8.7^{Aa}	7.8^{Bb}	8.0^{Ba}
60	7.2^{Bc}	8.0^{Aa}	7.9^{Ab}	7.8^{Ab}	7.8^{Ab}	7.1^{Bc}	7.1^{Bb}
90	5.5^{Cd}	7.0^{Ab}	6.9^{Ac}	6.5^{ABc}	6.5^{ABc}	6.3^{Bd}	6.2^{Bc}
Juiciness							
Zero	8.5^{Aa}	8.6^{Aa}	8.7^{Aa}	8.8^{Aa}	8.7^{Aa}	8.8^{Aa}	8.6^{Aa}
30	7.5^{Cb}	8.2^{Bb}	8.2^{Bb}	8.8^{Aa}	8.9^{Aa}	7.9^{BCb}	8.0^{B}[illegible]
60	7.3^{Bb}	7.9^{Ab}	7.8^{ABb}	7.9^{Ab}	7.8^{ABb}	7.3^{Bc}	7.3^{Bc}
90	5.7^{Cc}	6.7^{ABc}	6.5^{Bc}	7.1^{Ac}	7.1^{Ac}	6.6^{ABd}	6.4^{Bd}
Tenderness							
Zero	8.7^{Aa}	8.8^{Aa}	8.7^{Aa}	8.8^{Aa}	8.5^{Aa}	8.6^{Aa}	8.5^{Aa}
30	7.5^{Cb}	8.1^{Bb}	8.1^{Bb}	8.7^{Aa}	8.8^{Aa}	7.9^{BCb}	7.9^{BCb}
60	7.1^{Cb}	8.0^{Ab}	7.8^{Ab}	8.1^{Ab}	7.7^{ABb}	7.2^{BCc}	7.3^{BCc}
90	5.7^{Bc}	6.7^{Ac}	6.5^{Ac}	7.1^{Ac}	7.1^{Ac}	6.4^{Ad}	6.2^{Ad}
Overall acceptability							
Zero	8.8^{Aa}	8.8^{Aa}	8.7^{Aa}	8.7^{Aa}	8.8^{Aa}	8.7^{Aa}	8.6^{Aa}
30	7.8^{Bb}	8.2^{ABb}	8.2^{ABab}	8.6^{Aa}	8.6^{Aa}	7.9^{BCb}	7.9^{Bb}
60	7.4^{Bc}	7.9^{Ac}	7.8^{ABb}	8.1^{Aa}	8.0^{Ab}	7.3^{Bc}	7.4^{Bb}
90	5.7^{Dd}	6.7^{Bd}	6.6^{Bc}	7.0^{Ab}	6.8^{Ac}	6.3^{Cd}	6.0^{CDc}

a.b Any two means have the same superscript small letter within the same storage period for the same characteristics have no significant difference ($p > 0.01$)

A.B Any two means have the same superscript capital letter within the same fiber source for the same characteristics have no significant difference ($p > 0.01$)

Physical properties evaluation of sausage prepared with different fibers during frozen storage:-

Control beef sausage had significantly ($p<0.01$) higher cooking loss (15.69 %) than other samples. Low fat beef sausage (5 and 10 % dietary fiber) generally had lower significantly ($p<0.01$) cooking losses. Treatments containing 5 and 10 % artichoke leaves consistently had cooking losses (8.17 and 10.15 %) less than those of other dietary fiber. Backers and Noll (1997) found that sausages supplemented with wheat fiber and exposed to heating, smoking and freezing showed reduced wt. loss. Cooking yield was significantly ($p<0.01$) improved by dietary fibers types and levels (Table 7). This improvement could be due to the increased in moisture binding by the added fibers. High fat beef sausage (control) had the lowest cooking yield (84.27 %) whereas fiber containing samples tested had the highest cooking yield (86.27-91.39 % for the samples containing 5 % cabbage leafstalks and 10 % artichoke leaves, respectively) at zero time. The high losses of cooking yield in control beef sausage might be attributed to the excessive fat separation and water release during cooking. Similar results were obtained by Troutt *et al.* (1992) and Trius *et al.* (1994). Water holding capacity (WHC) is the ratio of moisture retained in sample to the initial moisture content, so higher percentage indicates release of less moisture (Pietrasik and Duda, 2000). Water holding capacity and plasticity of beef sausage samples containing selected concentration fibers were followed during storage of different sample at – 18 ^{0}C for 90 days and the results are given in Table (7). The control sample showed less WHC and plasticity compared with experimental samples at zero time, but, sample which contained 10 %artichoke leaves had the highest WHC and plasticity at zero time. All samples showed a decreasing trend in WHC and plasticity with increasing storage period at – 18 °C. These results agree with those reported by Defrritas *et al.* (1997) Hardness was influenced by both type and quantity of fiber (Table 7). The control sample showed a hardness values of 1715 lb/cm^2 and 2477 lb/ cm ^{2} for uncooked and cooked sausage, respectively, at zero time, while the addition of dietary fibers has decreased the hardness values. The lower value was achieved by 10 % artichoke leaves being 1262 lb/ cm^2 and 2019 lb/cm^2 for uncooked and cooked sausage, respectively, at zero time. Cooking of raw sausage in boiling water for 10 min has radically increased the hardness of the cooked sausage. Frozen storage has, generally, increased the hardness value of both raw and cooked sausage sample. The reason for such increase in hardness may be referred to the increasing number of starch granules ruptured upon freezing and thawing, absorbing higher amount of water upon heating which results in higher hardness in the frozen stored product. The reason for such behavior could be explained as reported by Berry, (1997). The hardness values during storage of samples containing dietary fiber sources were significant differences.

Table (7): Physical quality characteristics of beef sausage prepared with different dietary fiber sources during frozen storage at – 18°C

Dietary fiber% / Storage Period (days)	Control	Cabbage leafstalks		Artichoke leaves		Peanut hull	
	0	5	10	5	10	5	10
Cooking loss (%)							
Zero	15.69^{Ad}	12.41^{Cc}	11.46^{Dd}	10.15^{Ec}	8.17^{Fd}	13.60^{Bc}	11.69^{Dd}
30	16.57^{Ac}	14.50^{Bb}	12.76^{Cc}	11.60^{Db}	9.96^{Ec}	14.48^{Bb}	12.63^{Cc}
60	17.67^{Ab}	14.76^{Cb}	13.40^{Eb}	12.44^{Fa}	10.27^{Gb}	15.27^{Ba}	13.93^{Db}
90	23.40^{Aa}	15.60^{Ba}	14.16^{Ca}	12.16^{Da}	11.37^{Ea}	15.68^{Ba}	15.22^{Ba}
Cooking yield (%)							
Zero	84.27^{Ea}	86.27^{Da}	88.53^{Ca}	90.53^{Ba}	91.39^{Aa}	86.41^{Da}	88.51^{Ca}
30	83.63^{Eb}	85.28^{Db}	85.98^{Db}	88.29^{Bb}	89.87^{Ab}	85.47^{Db}	87.50^{Cb}
60	82.23^{Ec}	84.74^{Dc}	85.18^{Dc}	87.34^{Bc}	89.00^{Ac}	84.72^{Dc}	86.13^{Cc}
90	77.45^{Fd}	82.34^{Ed}	83.61^{Dd}	86.68^{Ad}	86.95^{Ad}	84.30^{Cc}	85.09^{Bd}
Water holding capacity (cm²/ 0.3g sample)							
Zero	8.28^{Ad}	7.15^{Bd}	5.99^{Dd}	5.23^{Ed}	4.51^{Gd}	6.14^{Cc}	5.15^{Fd}
30	8.51^{Ac}	7.21^{Bc}	6.45^{Cc}	5.40^{Fc}	4.82^{Gc}	6.30^{Dc}	5.61^{Ec}
60	8.75^{Ab}	7.39^{Bb}	6.59^{Cb}	5.89^{Eb}	5.02^{Fb}	6.43^{Db}	5.82^{Eb}
90	8.95^{Aa}	7.51^{Ba}	6.87^{Ca}	6.16^{Ea}	5.30^{Ga}	6.78^{Da}	5.97^{Fa}
Plasticity (cm²/ 0.3g sample)							
Zero	3.21^{Ga}	3.82^{Fa}	4.07^{DA}	٤,٢٨^{Ba}	4.45^{Aa}	3.95^{Ea}	4.15^{Ca}
30	3.04^{Fb}	3.53^{Eb}	3.91^{dB}	4.24^{bB}	4.30^{Ab}	3.90^{Da}	4.07^{Cb}
60	2.89^{Fc}	3.40^{Ec}	3.75^{dC}	4.10^{bC}	4.21^{Ac}	3.73^{Db}	3.92^{Cc}
90	2.67^{Gd}	3.33^{Fd}	3.60^{dD}	4.06^{bD}	4.14^{Ad}	3.46^{Ec}	3.74^{Cd}
Hardness of uncooked sausage (lp/ cm²)							
Zero	1715^{Ad}	1632^{Cd}	1610^{Dd}	1320^{Fc}	1262^{Gd}	1647^{Bd}	1551^{Ed}
30	1780^{Ac}	1712^{Bc}	1657^{Dc}	1376^{Fb}	1280^{Gc}	1691^{Cc}	1626^{Ec}
60	1845^{Ab}	1718^{Cb}	1670^{Db}	1416^{Ea}	1322^{Fb}	1729^{Bb}	1670^{Db}
90	2232^{Aa}	1939^{Ba}	1820^{Ca}	1413^{Fa}	1361^{Ga}	1772^{Dd}	1716^{Ea}
Hardness of cooked sausage (lp/ cm²)							
Zero	2477^{Ad}	2289^{Cd}	2170^{Ed}	2130^{Fd}	2019^{Gd}	2322^{Bd}	2237^{Dd}
30	2652^{Ac}	٢٤٥١^{Bc}	2263^{Ec}	2170^{Fc}	2116^{Gc}	2375^{Cc}	2295^{Dc}
60	3216^{Ab}	2656^{Bb}	2447^{Eb}	2215^{Fb}	2189^{Gb}	2416^{Cb}	2356^{Db}
90	3323^{Aa}	3184^{Ba}	2693^{Ca}	2421^{Fa}	2488^{Ga}	2590^{Ea}	2515Da

a.b… ..Any two means have the same superscript small letter within the same storage period for the same characteristics have no significant difference ($p > 0.01$)

A.B. . Any two means have the same superscript capital letter within the same fiber source for the same characteristics have no significant difference ($p > 0.01$)

REFERENCES

Ahmed, P.O., Miller, M.F . Lyon, C.E., Vaughters, H.M and Reagan, J.O (1990): Physical and sensory characteristics of low fat fresh pork sausage processed with various levels of added water J Food Sci 55:625-628

Anderson. J W (1991): Lipid responses of hypercholesterolemic men to oat bran and wheat bran intake. American J.of Clinical Nutrition, 54: 678-683

Ang, J.F (1991): Water retention capacity and viscosity effect of powdered cellulose. J. Food Sci. 56:1682-1684.

Ang, j.e. and Miller, W.B. (1991): Multiiple functions of powdered cellulose as a food ingredient .Cereal Foods World, 36:558-564.

AOAC (1990): Official Methods of Analysis, 15t^{h} edn. Association of Official Analysis Chemists, Washington, DC.

Backers, T and Noll, B. (1997): Dietary fibers for meat processing. Food Marketing & Technology;11:4-6, 8.

Baker, R.C.; Obrien, S.W. and Gossett, P.W. (1984): Development and evaluation of chickenburger formulation and effect of beating time incorporating under utilized poultry meats. Poultry Sci. 63:938-942.

Berry, B.W. (1997): Sodium alginate plus modified tapioca starch improvers properties of low fat beef patties. J. Food Sci.62:1245-1249.

Carballo, J.; Barreto, G. and Jimenez, F (1995): Starch and egg white influence on properties of bologna sausage as related to fat content. J. Food Sci. 60:673-677

Claye, S.S.; Idouraine, H and Weber, C.W (1998): In vitro mineral binding capacity of five fiber sources and their insoluble components for magnesium and calcium. Food Chem. 61:333-338.

Collins, J.L. and Post, A.R. (1981): Peanut hull flour as a potential source of dietary fiber. J. Food Sci. 46: 445-448, 451.

Defreitas, Z.; Sebranek, J.G., Olson, D.G. and Carr, J.M. (1997): Freeze\thaw stability of cooked pork sausages as affected by salt, phosphate, p^{H} and carrageenan J. of Food Sci. 62:551-554.

El-Deep, S.H. (1987): Studies on the quality of Egyptian sausage as determined by certain chemical and microbial changes. Ph.D Thesis. Fac Of Agric. Ain Shams Univ pp.

Femenia, A.; Lefebvre, A.C., Thebaudin, J.Y., Robertson, J.A. and Bourgeois, C.M. (1997): Physical and sensory properties of model foods supplemented with cauliflower fiber. J Food Sci. 52:635-639

Fleury, N. and Lahaya, M. (1991) Chemical and physico-chemical characterisation of fibers from Laminaria digitata (Kombu Breton) :a physiological approach.J .Sci. Food Agric. 55:389-400.

Galal, W.K. (1998): Quality characteristics of macaroni as affected by addition of some by products rich in fiber. M.Sc. Theses, Fac. of Agric., Cairo Univ.

Gorecka, D; Lampart, E., Janitz, W. and Sokolowska, B. (2000): Composition of fractional and functional properties of dietary fiber of lupines (L.luteus and L.albus). Nahrung;44:229-232.

Hegazy, N.A. Mekawy, A.A. and Hassona, H.Z (1991): Influence of different levels of peanut hull flour on physical and sensory evaluation of low calorie cakes. Nahrung, 35:821-826. (abst.).

Hoelscher, L.M.; Savell, J.W.; Harris, J.M., Cross, H.R. and Rhee, K.S. (1987) Effect of initial fat level and cooking methods on cholesterol content and calorie value of ground beef patties. J Food Sci. 52:883-885

Idouraine, A.; Khan, M.J. and Weber, C.W. (1996): In vitro binding capacity of wheat bran, rice bran and oat fiber for Ca, Mg, Cu and Zn alone and in different combinations .J .Agric. Food Chem. 44:2067-2070.

Khalon, T.S. and Chow, F.I. (2000): In vitro binding of bile acids by rice bran, oat bran, wheat bran and corn bran. Cereal Chem. 77:518-521.

Klein, B.P. and Bardy, P.L. (1984): Experimeintal food. Department of Food and Nutrition, Univ. Of LIlinois.pp.

Kuniak, L. and Marchessult, R.H. (1972): Study of cross linking reaction between epichlorhydrin and starch . Starch\ starke 4:110-116. (c.f., Femenia, *et al.*, 1997)

Levarate-Verny, M.A.; Caudray, C.; Bellanger, J. and Remsy, C. (1999): Wholemeal wheat flour ensures higher mineral absorption and bioavailability than white wheat flour in rats. British J. Nutr. 82:17-21.

Mansour, E.H. and Khalil, A.H. (1997): Characteristics of low-fat beefburger as influenced by various types of wheat fibers. Food Res. 30: 199-205.

Matsuo, M (1995): Application of new fiber foodstuff, okara tempe, to hamburger steak and cupcake .J. of Japanese Society of Nutrition and Food Science;48:141-145. (abst.).

Meullenet, J.F.; Chang, H.C.; Carpente, J.A.; Resurreccion, A.V.A. (1994). Textural properties of chicken frankfurters with added collagen fibers.J.Food Sci.59:729-733.

Miller, M.F.; Anderson, M.K.; Ramsey, C.B. and Reagan, J.O. (1993). Physical and sensory characteristics of low fat ground beef patties.J.Food Sci. 58:461-463.

NCI (1984). Diet, nutrition and cancer prevention: a Guide to Food Calories. National Cancer Institute, US. Dept. of Health and Human Services. NIG Pub.85-2711.

Pearce, K.N. and Kinsella, J.E. (1978). Emulsifying properties of proteins: Evaluation of a turbidimetric technique. J. Agric. Food Chem. 26:716-723.

Pietrasik, Z and Duda, Z. (2000). Effect of fat content and soy protein I. Carrageenan mix on the quality characteristics of comminuted, scalded sausage. Meat Sci. 56:181-188.

Prakongpan, T.; Nitithamyong, A. and Luangpituksa, P. (2002). Extraction and application of dietary fiber and cellulose from pineapple cores. J.Food Chem. 67:1308-1313.

Prosky, L.;Asp, N.G.; Scheizer, T.F.; Devries, .J.W. and Furda, I. (1988). Determination of insoluble, soluble and total dietary fiber in foods and food products. Inter laboratory study, J. Anal. Chem. 71: 1017.

Ranhotra, G. and Gelroth, J. (1985). Dietary fiber. Res .Dept.Tech. Bull, Vol. 7. No. 10.Am.Inst. of Baking, Manhattan, Kans.

Ranhotra, G.S.; Gelroth, J.A. and Astroth, K. (1990). Total and soluble fiber in selected bakery and other cereal products. Cereal Chem. 67:499-503.

Sanderson, G.R.; Bell, V.L.; Clark, R.C. and Orterya, D. (1988). The texture of gellan gum gels. In Gums and Stabilizers for the Food Industry 4. G.O. Philips, D.J. Wedlock and Williams, P.A. (Ed) :219-229.IRL press, Washington, DC. (C.f. Defreitas, *et al.*, 1997).

SAS (1996). Statistical Analysis System. SAS User s, Guide Release 6.04 Edition Statistical SAS institute Inc. Editors, CARY. NC.

Schneeman, B.O. (1986). Dietary fiber: Physical and chemical properties methods of analysis and pysiological effect. Food Technol. 40:104-108.

Shehata, H.A. (1989). Studies on nitrate and nitrite in meat products. Ph.D. Thesis. Fac. Of Agric. Suez Canal Univ. pp.

Sosulski, F.W.and Cadden, A.M. (1982). Composition and physiological properties of several sources of dietary fiber .J. Food Sci.47:1472-1476.

Stear, C.A. (1990). Formulation and processing techniques for specialty bread . In Handbook of breadmaking technology, C.A.Stear (Ed.). London: Elsevier Science.

Stephen, A.M. (1995). Food polysaccharides and their applications, 1st ed. New York:Marcel Dekker.

Thibault, J.F.; Lahaye, M. and Guillon, F. (1992). Physico-chemical properties of food plant cell walls.In Dietary fiber-Acomponent of food, Schweizer and C.A.Edwards (Ed.) p.21-39.Springer Verlag, London.

Torre, M.; Rodriguez, A.R. and Calixato, F.S. (1995). Interactions of Fe (II), Ca (II) and Fe (II) with high dietary fiber materials: A physicochemical approach . Food Chem. 54:23-31.

Trius, A.; Sbranek, J.G.; Rust, R.E. and Carr, J.M. (1994). Low fat bologna and beaker sausage: effect of carrageenans and chloride salts. J.Food Sci. 59:941-945.

Troutt, E.S.; Hunt, M.C.; Johnson, D.E.; Claus, J.R. Kastner, C.I. and Kropf, D.H. (1992). Characteristics of low fat ground beef containing texture modifying ingredients. J.Food Sci.57:19-24.

Volovinskaia, V.P. and Merkoolora, V.K. (1958). Methods for determination of meat water holding capacity, affice of technical information. All Union Scientific Res. Inst of Meat Industry 9:40-44.

Wolever, T.M. (1990). Relationship between dietary fiber content and composition in foods and the glycemic index. Am. J.Clinical Nutrition, 51: 72-75.

Zaika, L.L.; Zeel, T.E.; Palumbo, S.A. and Smith J.L. (1978). Effect of spices and salt fermentation of letaron bolagatype sausage. J.Food Sci. 43:186-190

خصائص الجودة للسجق البقرى منخفض الدهن المحتوى على الياف غذائية مختلفة

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استخدم فى هذة الدراسة كل من عروق الكرنب و اوراق الخرشوف و قشور الفول السودانى الجافة كنواتج ثانوية لمصانع الاغذية بتركيزات تراوحت بين ٥-٢٠% كنسبة مستبدلة من الدهن فى السجق البقرى،تم تقييم الخصائص الكيميائية،الطبيعية والحسية للسجق المنتج .احتوت عينات السجق المطهية والمصنعة فى وجود ٥و١٠% الياف غدائية على محتوى رطوبى، بروتين ،رماد وكربوهيدرات اعلى ومحتوى دهن اقل مقارنة بالعينة الكنترول . ادت أضافة المصادر المختلفه من الالياف الغذائيه الى خفض المحتوى الدهنى لعينات السجق بنسبه تتراوح بين ٢٤,٧٤ الى ٣٩,٨٣%. سجلت عينات السجق المحتوية على مصادر الالياف الغدائية فاقد الطهى والذى بلغ ٨,١٧، ١٣,٦٠% للعينات المحتوية على ١٠% اوراق خرشوف و٥% قشر فول سودانى على التوالى مقارنة ب ١٥,٦٩ % للعينة الكنترول كما سجلت عينات السجق المحتوية على٥ ،١٠ % اوراق خرشوف اعلى حصيلة طهى (٩٠,٥٣ و ٩١,٣٩%) فى بداية التخزين ولكن اثناء التخزين تحت ظروف التجميد حتى ٩٠ يوم حدث نقص معنوى فى حصيلة الطهى (٨٦,٦٨ و ٨٦,٩٥) مقارنة بالعينة الكنترول حيث انخفضت من ٨٤,٧٥ الى ٧٧,٤٥ % . وبنفس الاتجاه سجلت العينات المحتوية على مصادر الالياف الغذائية المختلفة معنوية اعلى فى البلاستيكية مقارنة بالعينة الكنترول عند بداية التجربة واثناء التخزين. كما اظهرت قيم قياس القدرة على الاحتفاظ بالماء (سم^{٢} / ٠,٣ جم عينة) نمط مماثل للصلابة. حدث نقص معنوى فى قيم الصلابة لعينات السجق البقرى الخام و المطهى عن العينة الكنترول. ادت عملية طهى عينات السجق لمدة ١٠ق فى الفرن الى حدوث زيادة ملحوظة فى قيم الصلابة للعينات بعد الطهى . واوضحت النتائج ان تخزين عينات السجق المختلفة بالتجميد ادت الى حدوث نقص فى قيم الصلابة في كلا من العينات الخام والمطهية . اظهرت العينات المصنعة ب ٥و١٠% الياف غذائية تغير معنوى اقل فى الخصائص الحسية اثناء التخزين بالتجميد . خلاصة يمكن استخدام مصادر الالياف الغذائية المختبرة بمستوى ٥و١٠ % كبدائل للدهن بنجاح فى تحسين خصائص السجق البقرى.