FOOD GRADE COLLAGEN AS A HAMBURGER EXTENDER

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Story in Brief

Food grade collagen was added to ground beef at 0, 10 and 20 percent levels, replacing lean meat, and stored at 5 F (-15 C) for up to 2 weeks to evaluate the effect of collagen level and storage time on the quality of the product. A semitrained panel evaluated for quality such characteristics as flavor, juiciness, texture and overall acceptability. The product was also analyzed for color, texture, cooking loss and chemical rancidity. Beef patties with collagen were found to be superior ($P < 0.05$) in texture and juiciness by the taste panel, while the overall acceptability and flavor decreased as the collagen level increased. However, no significant differences were observed for these attributes due to storage time. Collagen was found to bind moisture, as indicated by the fact that there was no significant cooking loss either due to the replacement levels or storage. The addition of collagen resulted in a lighter colored patty, which was influenced by collagen level and storage period. The product tended to become less cohesive upon collagen replacement, which decreased the texture, but the texture improved upon storage, reflecting hardening of collagen and muscle fibers during storage. The chemical rancidity as measured by TBA test, reduced significantly as the collagen levels increased and was not influenced by storage.

Introduction

Hamburger has developed into an integral part of the American diet. Food service as well as hotels, restaurants and institutional feeding is expanding into worldwide markets, and the ground beef patty is becoming commonplace around the world. The Food Nutrition Service of USDA has approved the use of textured soy protein at levels as high as 30 percent for school lunch programs. However, a significant prejudice exists among consumers against meat analogs. Attempts are being made to utilize other proteins like milk, whey, cottonseed, etc. as ground beef extenders with varied results. Hide protein collagen, because of its biophysical properties is useful as an extender, moisturizer, texturizer or emulsifier in different food systems. Collagen has been found to be bacteriologically safe for human consumption, bland in flavor and odorless. These functional properties make collagen a potential ground beef extender. Therefore, this study was undertaken

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to determine the effect of replacing lean meat at 0, 10 and 20 percent levels in a hamburger patty and to evaluate the effect of storage on color, texture, degree of rancidity, and quality by sensory evaluation.

Experimental

USDA good grade beef round and beef fat was obtained from a local meat packer. The fat and lean was manually separated and ground separately, once through 1/2 in. plate of a meat grinder. The initial fat content of the lean meat and fat meat was determined by a rapid fat testing procedure. The lean and fat were packaged separately in a freezer paper and frozen at 5 F until used. Before making final mixes, the meat was removed from the freezer, thawed overnight at about 40 F. The lean was divided into 3 batches, and in each batch, the lean meat was replaced with hide collagen (product #4 provided by the USDA Eastern Regional Research Center, Philadelphia) at 0, 10 and 20 percent levels, maintaining a 25 percent fat level in each batch. All the ingredients were blended for 3 min using a Hobart mixer. Each batch was ground through an 1/8 in. plate to provide uniform distribution of the fat, lean and collagen. Patties weighing approximately 4 oz (dia. 4.5 in.; thickness 3/10 in) were formed using a Hollymatic 200, patty molding machine. Patties were interleaved with wax-coated paper and placed two in a plastic foam tray and overwrapped with clear polyvinyl chloride oxygen permeable film and stored at 5 F (-15 C) for up to 2 weeks.

Patties were analyzed for protein, fat and moisture following AOAC procedures. Cooking loss was determined by cooking patties on a preheated electric griddle set at 275 F (135 C), for 5 min on one side and 4 min on the other side to achieve an internal temperature of 150 F (65.5 C). Cooking loss was calculated by subtracting the cooked weight from the weight of the patty before cooking and expressed as percentage. Color of the raw and cooked patties was evaluated using a Hunter Lab Tristimulus colorimeter. The exposed surface of the patty was allowed to oxygenate for approximately 30 min at room temperature. The surface was blotted and presented to the specimen port of the optical sensor and triplicate L (lightness-darkness), a (redness, greenness), and b (yellowness-blueness) readings were taken at 3 differrent areas of each patty. Texture of the cooked patty was measured using an Instron Universal Testing Instrument with a Lee Kramer shear cell after cooking the patty and cooling it to room temperature. Three 1 in. core samples were taken from each using a hand coring device. The cores were weighed and placed on the shear cell; the rate of crosshead and chart speed were calibrated at 100 mm/min, scale load at 5, and the maximum shear force was recorded. Oxidative rancidity was determined both for raw and cooked patties as Thiobarbituric acid (TBA) values and expressed as concentration of malonaldehyde (mg/kg). Evaluation for flavor, juiciness, texture and overall acceptability of cooked patties was done using a semi-trained panel of 6-9 members. The panelists evaluated the samples on a 7 point hedonic rating scale as follows:

Ground beef flavor and intensity: 7 = intense beef flavor; 1 = extremely off-flavor

Juiciness: 7 = extremely juicy; 1 = very dry

Texture: 7 = extremely cohesive; 1 = very crumbly

Overall acceptability: 7 = like extremely; 1 = dislike extremely

All the results were analyzed statistically using the appropriate statistical methods.

Results and Discussion

Chemical composition of the patties was not affected by the collagen replacement levels, and the products contained equal percentages of protein, fat and moisture. Therefore, valid comparisons can be made on the effects of hide collagen when added to ground beef patties.

Cooking loss, TBA value, color, texture and sensory attributes as affected by collagen replacement levels are presented in Table 1 and as affected by storage time are shown in Table 2. Neither the collagen replacement levels, the storage period, nor the interaction of collagen level and storage period influenced the cooking loss (P = Ø.39).

Collagen levels significantly affected the TBA values of the uncooked patties; as the collagen replacement of lean meat increased, a lower concentration of malonaldehyde was obtained. No significant variation was found due to storage period and interaction between collagen level and storage.

The development of rancidity, as measured by TBA values, was less for patties containing 2Ø percent collagen. Hematin compounds such as myoglobin catalyze oxidation of unsaturated lipids and this catlytic activity is completely dependent on the presence of iron. The decreased lean tissue, as a result of replacement with iron-free collagen, resulted in a decreased TBA value. The small increase in TBA value although not significant during 1 week of storage, was due to the oxidation of unsaturated fatty acids, which were accelerated by the presence of oxygen. A slight rise in TBA value during 2 week storage, although not significant may be due to the accumulation of certain metabolites and formation of less volatile and/or stable compounds that fail to react with TBA reagent. In the cooked patties, the collagen levels and storage period significantly affected the TBA values. The higher TBA values in cooked patties, as compared to raw patties, indicated that cooking accelerated the oxidation.

The Hunter color values for uncooked patties showed a significant increase as the collagen levels increased and also a significant increase due to storage time. As the

Table 1. Cooking loss, TBA values, color, texture, and sensory attributes as affected by collagen level (mean values).

Measurement	% Collagen		
	0	10	20
Cooking loss %	30.56	30.45	30.68
TBA value (mg/kg)			
cooked	2.50	2.11	1.67
raw	1.99a	1.53b	1.13c
Color (cooked)			
L	40.13	40.20	41.33
a	5.38a	5.48b	6.00c
b	11.36	11.30	11.24
Color (raw)			
L	48.85a	51.48	53.53c
a	13.48	11.66	11.15
b	11.61	13.87	12.26
Texture (kg/g)	3.67a	3.48b	3.26c
Sensory attributes			
Flavor	5.39a	4.67b	3.18c
Juiciness	4.38a	4.89b	4.53a
Texture	4.96a	3.78b	2.84c
Overall	5.00a	4.78b	2.92c

Means in a column which are not followed by the same letter are different ($P<0.05$).

lean meat is replaced with white collagen the patties became lighter in color as expected. The increase in L color values because of storage is due to discoloration as a result of oxidation of myoglobin (red color of meat) to metmyoglobin (brown color). The Hunter "a" and "b" values did not show any significant difference either due to collagen replacement levels or storage time. For the cooked patties, the Hunter "L" and "b" values were not significantly different, however the "a" values were significantly affected by the collagen level and storage time. Since the color of cooked patties is a result of measurement of "L", "a" and "b" values, a significant variation in any one value will result in a variation of color in the final product. This variation is expected since the meat color depends upon pigment level, degree of

Table 2. Cooking loss, TBA value, color, texture and sensory attributes as affected by storage time (mean values)

Measurement		storage weeks	
	0	1	2
Cooking loss %	30.61	30.50	30.58
TBA value (mg/Kg)			
cooked	2.03	2.46	1.79
raw	1.57a	1.59a	1.50a
Color (cooked)			
L	39.51	41.57	40.55
a	6.07a	5.75b	5.05c
b	11.31	11.36	11.22
Color (raw)			
L	50.30a	51.69b	51.99c
a	12.16	13.15	10.84
b	12.70	11.60	13.48
Texture (Kg/g)	2.97c	3.51b	3.93a
Sensory attributes			
Flavor	4.46	4.35	4.43
Juiciness	4.65	4.68	4.48
Texture	3.82	3.86	3.90
Overall	4.24	4.20	4.27

Means in a column which are not followed by the same letter are different ($P<0.05$).

myoglobin denaturation, iron oxidation, the decomposition and polymerization of carbohydrates, fats and protein. Even though the patties at the three collagen levels had characteristics similar in terms of protein, moisture and fat, collagen lacks the heme pigment myoglobin.

Tenderness, one of the main attributes associated with meat texture, was measured by the Kramer shear force and expressed as kg/g of beef patty. The shear force values of cooked patties decreased ($P < .05$) as the collagen levels increased and during storage period, showed an increase ($P < .05$). Due to replacement of lean with collagen, the texture of the product decreased and the tenderness values decreased, due to gelatinization of collagen during cooking. The significant increase of mean shear force, due to length of storage may reflect the hardening of the muscle fibers and collagen, increasing the cohesiveness or internal bonding strength of the meat.

Flavor, juiciness and overall acceptability of the cooked patties were measured during 46 tasting sessions with 6-9 semitrained panelists.The flavor of the ground beef decreased ($P < .05$) as the collagen content increased, which is expected since collagen has a bland flavor. The juiciness scores were higher ($P < .01$) as the collagen level increased. This is attributed to the higher water binding ability of collagen. The overall acceptability scores decreased ($P < .01$) as the collagen levels increased. The lowest mean score was determined as dislike slightly. At no time were the samples scored as extremely undesirable. The sensory scores were not affected by storage time.

The data provide evidence that beef patties prepared with collagen were superior in texture and juiciness when compared to those with no added collagen, but the flavor and overall acceptability decreased as the collagen levels increased.