# STRUCTURED BEEF STEAKS WITH FOOD GRADE COLLAGEN

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## Story In Brief

Food grade collagen, in the form of an enzymatically hydrolyzed powder, a native 10% paste or a dry fibrous material, was added to chunked beef chuck at 0, 1, 2, 3, 4, 6 or 8 percent level to make structured beef steak. Meat containing hydrolyzed collagen powder while improving the cooked yield decreased the bind value and Kramer shear value of the cooked steak. The color of the uncooked steak was not affected. Native collagen paste improved the cooked yield and bind value. The Kramer shear value of the cooked steak and the surface color of the uncooked steak were not affected. The addition of dry fibrous collagen to chunked beef resulted in a higher cooked yield of roasts only at 8% level but the bind and shear value were decreased. The surface color value of the uncooked steak decreased with increasing levels of collagen. Based on this study it was concluded that the native collagen 10% paste could be used to manufacture uncooked structured beef steak with desirable surface color, good bind and cooked texture.

[Key Words: Collagen, Structured Beef]

## Introduction

Beef steak is one of the most desired consumer products and is expensive since only a limited volume of high quality muscle exists in the carcass. The meat industry is constantly striving to upgrade the lower priced cuts by processing them into products with steak like texture. Restructuring permits one to take lower value cuts to be upgraded into desirable meat products of uniform shape, size, texture and therefore economic value. There is an increasing demand in the hotel, restaurant and institutional trade for restructured meat. This demand is expected to increase in view of the availability of a steak with desired levels of fat and nutrients, shape, size and texture. Several techniques such as grinding, flaking, chunking and reforming the meat into steaks are used. Massaging and tumbling to disrupt the muscle fiber, releasing of salt soluble protein, coating of meat with soluble protein and heat coagulating the protein coat by cooking to form a binding matrix are other techniques. Chemicals like sodium chloride to increase the extractability of salt soluble protein and polyphosphates to improve the juiciness and cooking yield are used in conjunction with other techniques in making restructured products.

Some of the above techniques have undesirable side effects. For example massaging and tumbling in presence of atmospheric oxygen incorporates oxygen in the products and may cause oxidative changes on storage. Sodium chloride while facilitating the extraction of salt soluble protein may cause undesirable color changes on storage. The meat industry is searching for more economical ways to produce these products with minimal undesirable side effects.

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The purpose of this investigation was to use food grade collagens for manufacturing structured beef steaks without the addition of any other chemicals.

## Materials and Methods

Food grade collagens, in the form of an enzymatically hydrolyzed powder, native 10% paste and dry fibrous material, were obtained from a private manufacturer[a]. Good grade beef chucks were obtained from a local meat packer.

The beef chucks were deboned, excess fat and connective tisssue trimmed and passed through a hand operated blade tenderizer twice. The tenderized meat was ground through the kidney plate of a meat grinder once. The meat chunks were mixed with each of the collagens at 0, 1, 2, 3, 4, 6 or 8% level in a paddle type mixer for 20 min. The mixture was hand stuffed into 4 in fibrous casings and frozen in a blast freezer for 24 hr. The frozen logs were tempered at -3 C for 24 hr and pressed at 2000 psi for 2 min. in a carver press and refrozen at -12 C for 24 hr. One half of the frozen logs were cut transversely into 1 in. steaks and the other half was used as a roast for subsequent cooking. The experiment was repeated three times.

### Cooking

The frozen roasts were cooked in a convection oven to an internal temperature of 70 C. The temperature was monitored with copper constant temperature probes inserted into approximately the geometric center. The frozen steaks were cooked on an electric broiler to the same internal temperature (70 C). Cooked yield was calculated by weighing the roasts or steaks before and after cooking. Triplicate samples were used for each of the collagen levels.

### Bind Values

The cooked roasts were cut into 1 in slices transversely and each slice was used to measure the bind value. The cooked slice was mounted on a cylindrical hollow plastic holder (3 in. dia.) with sharp needles on its circumference spaced about 3 mm apart. The needles held the slice in position. The plastic holder with the meat slice was kept in position under the cross head of an Instron Universal Testing Machine. The cross head was fitted with a cylindrical plunger having a rounded end (1 in. dia.). The cross head and chart speed were adjusted to move at 100 mm/min. The peak force in kg was measured and recorded when the plunger penetrated to break the meat chunks and expressed as bind value in kg. The bind value for the cooked steaks was measured similarly. All measurements were taken on triplicate samples.

### Kramer Shear Values

The tenderness of the cooked roasts and steaks was measured by placing a one inch square piece in a Kramer shear cell fixed to an Instron Universal Testing Machine and recording the peak force required for the shear. The tenderness values of triplicate samples were expressed as kg/g.

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[a]Courtesy, Marsales Siegler, Seton Company Philadelphia, PA.

### Chemical Composition

The uncooked and cooked samples were analyzed for protein, fat and moisture following the AOAC methods. The pH of the uncooked samples was measured using a Fisher pH meter with a combination glass electrode. All measurements were in triplicate.

### Surface Color

The surface color of the uncooked steaks was measured on the L, a, b scale using a Hunter Lab tristimulus colorimeter. The frozen steaks wrapped in freezer paper were thawed overnight in a cooler at 5 C. After unwrapping, the steaks were allowed to bloom for 30 min. at room temperature (23 C) before placing them under the optical port of the colorimeter.

## Results and Discussion

### Cooked Products with Hydrolyzed Collagen

The addition of hydrolyzed collagen powder to the beef chunks did not affect (P>0.05) the protein, fat and moisture content of the cooked structured products (Table 1). The cooked yield was not significantly

Table 1. Chemical composition, yield, bind, Kramer shear values of cooked and surface color of uncooked structured beef with hydrolyzed collagen.

| Coll lev | Prot | Fat | Moist | Cooked yield | | Bind kg | | Kramer shear-kg | | Color 'a' value |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | R | S | R | S | R | S | |
| % | % | % | % | % | % | | | | | |
| 0 | 31.9 | 7.0 | 60.4 | 72.0 | 61.7$^{b}$ | 3.7$^{a}$ | 6.1$^{a}$ | 6.8$^{a}$ | 9.4 | 12.0 |
| 1 | 30.6 | 6.6 | 61.8 | 79.0 | 65.5$^{b}$ | 3.4$^{b}$ | 5.8$^{a}$ | 6.4$^{a}$ | 7.2 | 12.4 |
| 2 | 30.0 | 6.8 | 62.1 | 77.8 | 66.4$^{b}$ | 3.4$^{b}$ | 3.9$^{b}$ | 6.7$^{a}$ | 7.2 | 13.2 |
| 3 | 31.7 | 6.4 | 60.7 | 76.6 | 67.3$^{b}$ | 3.4$^{b}$ | 4.7$^{b}$ | 6.9$^{a}$ | 7.1 | 12.4 |
| 4 | 30.3 | 6.1 | 62.6 | 77.9 | 69.8$^{a}$ | 3.0$^{b}$ | 4.2$^{b}$ | 6.3$^{b}$ | 7.5 | 13.2 |
| 6 | 32.5 | 5.3 | 61.2 | 72.2 | 72.4$^{a}$ | 2.6$^{b}$ | 3.8$^{b}$ | 6.2$^{b}$ | 6.8 | 13.0 |
| 8 | 34.9 | 5.3 | 58.8 | 71.8 | 69.1$^{a}$ | 2.8$^{b}$ | 3.5$^{b}$ | 5.7$^{b}$ | 6.6 | 12.4 |

R=roast; S=steak
Color = Hunter 'a' value, redness-greenness
[a,b] Means in each column with no. or same superscript letter are not different (P>0.05)

affected when the products were cooked as roasts but the steak yield increased ($P<0.05$) as the collagen level increased from 4% to 8% suggesting that the added collagen helped to improve the water binding capacity of the meat proteins. The bind value and Kramer shear value showed a significant decline with increasing levels of collagen. Even though the protein level remained the same, some of the functional properties of the muscle proteins were altered. Myosin is the muscle protein mainly responsible for binding of the meat chunks. During mixing some myosin is extracted and forms a matrix between the meat chunks. Cooking coagulates the myosin and thus binds the meat chunks. The added collagen would have diluted this effect resulting in weaker binding. The decreased shear values is likely due to improved water holding.

Surface color of the uncooked steak was not affected ($P>0.05$) due to the addition of collagen.

Cooked Products with Native Collagen Paste

The chemical composition (Table 2) of cooked products was not affected ($P>0.05$) by the addition of collagen. The cooked yield of roasts increased significantly with increased levels of collagen between

Table 2. Chemical composition, yield, bind, Kramer shear values of cooked and surface color of uncooked structured beef with native collagen paste 10%.

| Coll lev | Prot | Fat | Moist | Cooked yield | | Bind kg | | Kramer shear-kg | | Color 'a' value |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | R | S | R | S | R | S | |
| % | % | % | % | % | % | | | | | |
| 0 | 31.8 | 6.9 | 60.4 | $72.0^b$ | $61.7^a$ | 3.7 | 6.1 | 6.8 | 9.4 | 11.7 |
| 1 | 28.3 | 6.3 | 64.4 | $74.0^b$ | $61.8^a$ | 3.8 | 6.5 | 6.9 | 9.1 | 11.5 |
| 2 | 29.8 | 5.8 | 63.3 | $74.1^b$ | $59.7^b$ | 4.0 | 6.4 | 7.0 | 9.7 | 11.6 |
| 3 | 31.4 | 5.6 | 61.9 | $73.2^b$ | $60.5^b$ | 4.5 | 6.9 | 7.2 | 9.2 | 11.8 |
| 4 | 31.9 | 5.0 | 62.1 | $74.6^a$ | $60.3^b$ | 4.8 | 6.8 | 6.5 | 8.7 | 12.0 |
| 6 | 32.5 | 5.2 | 59.7 | $74.5^a$ | $59.8^b$ | 4.8 | 6.4 | 6.8 | 9.1 | 11.7 |
| 8 | 32.5 | 6.1 | 60.3 | $74.8^a$ | $59.1^b$ | 5.7 | 6.3 | 6.5 | 8.9 | 12.0 |

R=roast; S=steak
Color = Hunter 'a' value, redness-greenness
[a,b] Means in each column with no or same superscript letter are not different ($P>0.05$)

4 to 8% while that of steaks showed significant decline with increased collagen levels. These differences may be due to the different methods of cooking. The roasts were cooked at a relatively lower temperature while the steak surface was exposed to high temperature during electric broiling. The bind value, Kramer shear value and Hunter color value remained same as that of controls at all levels of added collagen.

## Dry Fibrous Collagen

The addition of dry fibrous collagen did not affect ($P>0.05$) the chemical composition of cooked products (Table 3). The cooked yield of roasts showed a significant increase only at the 8% level of added collagen while there were no differences ($P>0.05$) when the products were cooked as steaks. The bind values of roasts and steaks at all levels of added collagen decreased ($P<0.05$) compared to controls suggesting that the collagen interfered with the binding ability of muscle proteins. The shear values of both roasts and steaks decreased ($P<0.05$) with increasing levels of added collagen. The Hunter 'a' values significantly decreased at collagen levels between 4 to 8%. The grayish white color of collagen diluted red pigment of myoglobin.

Table 3. Chemical composition, yield, bind, Kramer shear values of cooked and surface color of uncooked structured beef with dry fibrous collagen.

| Coll lev | Prot | Fat | Moist | Cooked yield | | Bind kg | | Kramer shear-kg | | Color 'a' value |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | R | S | R | S | R | S | |
| % | % | % | % | % | % | | | | | |
| 0 | 31.3 | 7.0 | 60.5 | $72.0^b$ | 61.7 | $3.7^a$ | $6.1^a$ | $6.8^a$ | $9.4^a$ | $11.4^a$ |
| 1 | 31.9 | 6.2 | 60.9 | $70.9^b$ | 63.0 | $2.3^b$ | $2.6^b$ | $4.2^b$ | $8.0^a$ | $9.8^a$ |
| 2 | 31.7 | 6.7 | 61.5 | $70.2^b$ | 65.9 | $2.4^b$ | $3.0^b$ | $4.4^b$ | $5.0^b$ | $8.9^a$ |
| 3 | 31.8 | 6.5 | 60.5 | $75.2^b$ | 65.9 | $2.6^b$ | $2.9^b$ | $4.0^b$ | $4.8^b$ | $8.7^a$ |
| 4 | 32.3 | 6.5 | 59.8 | $72.2^b$ | 67.3 | $2.5^b$ | $2.2^b$ | $3.5^b$ | $4.6^b$ | $8.1^b$ |
| 6 | 32.2 | 6.6 | 60.1 | $75.4^b$ | 69.4 | $2.5^b$ | $1.7^b$ | $4.0^b$ | $4.2^b$ | $7.2^b$ |
| 8 | 31.1 | 5.4 | 62.4 | $76.2^a$ | 72.1 | $2.9^b$ | $1.5^b$ | $3.9^b$ | $3.8^b$ | $6.6^b$ |

R=roast; S=steak
Color = Hunter 'a' value, redness-greenness
$^{a,b}$ Means in each column with no or same superscript letter are not different ($P>0.05$)

## Conclusions

The cooked yield increased with increasing levels of hydrolyzed collagen in the structured meat product while the bind value and Kramer shear value declined. The surface color of the uncooked steaks was not affected. The native collagen paste when added to the structured meat improved the cooked yield of roasts as the collagen content increased while the bind, shear value and the surface color of uncooked steaks was not affected. The dry fibrous collagen while improving the cooked yield of roasts only at 8% level, decreased the bind value, Kramer shear value and surface color of the uncooked steaks.

Based on this study it may be concluded that the native collagen 10% paste may be a suitable raw material that could be used in manufacturing structured beef steaks without any other additives to improve yields, bind or color.

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