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Desiccated Pancreas as a Meat Tenderizer

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SUMMARY

Desiccated pancreas was applied to beef round at two levels of concentration and of pH. In tenderness, texture, juiciness, flavor, and general acceptability mean panel scores were higher for treated samples than for untreated controls with the differences being significant for juiciness. Means of subjective and objective measurements for tenderness reflected the same order of improvement, although the differences were not significant when measured by analysis of variance. At different enzyme levels, raising the pH resulted in slightly higher means for all attributes with lesser amounts of enzyme; whereas with greater amounts of enzyme, mean scores were slightly lower at the higher pH except for flavor.

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INTRODUCTION

Little research has been reported on the use of enzymes from animal sources as meat tenderizers. Wang *et al.* (1958) employed both histological and sensory tests in studying tenderization of meat by microbial, fungal, and pancreatic enzymes. However, only histological data were presented on the phase of the study dealing with pancreatic enzymes.

Among the many studies on plant enzymes as meat tenderizers are those of Hay *et al.* (1953), Weiner *et al.* (1958), and Mier *et al.* (1962), all of whom reported positive results. The last authors found that piercing the enzyme into the meat caused more tenderization than did surface application of the enzyme.

The study reported here was undertaken to determine the effectiveness as a meat tenderizer of whole raw pancreas containing trypsin, chymotrypsin, amylase, lipase, peptidases, esterases, elastase, collagenase, ribonucleases, and other enzymes found in hog pancreas.

METHODS AND MATERIALS

The procedure adopted for this study was based on preliminary exploratory work and on recommendations of the manufacturer of the pancreatin preparation.

Additives. To obtain the equivalents of ¼ and ½ teaspoon per pound of meat, 0.825 mg and 1.65 mg of enzyme were used per gram of meat. These amounts of enzyme are referred to as the low- and high-enzyme treatments. Table salt (NaCl) was added at 2½ mg per gram of meat to all treated samples and controls. This weight was the equivalent of ½ teaspoon of salt per pound of meat. In one-half of the enzyme-treated samples, sodium bicarbonate was added at the rate of 4% of the weight of enzyme, bringing the pH to approximately 7.3. This is referred to herein as the alkaline-enzyme treatment. The pH of the other half of the treated samples was unaltered from the natural pH of approximately 6. For ease of application, all additives were carried in 6 ml of distilled water per sample of meat.

Meat Preparation Procedure. Ten U.S. Standard grade top rounds were purchased at a retail store. Each round was frozen, and sliced while frozen, into

six slices 1 inch thick. The *semimembranosus* muscle from each slice was removed and held at -5°F for use in this study. Weight of the steaks ranged from 227 to 283 g (avg. 273 g). The six slices from one round were used in one day of testing, and a systematic pattern for selection of steaks for treatment was set up which minimized the effect of position of slice on treatment.

Steaks were thawed in a refrigerator overnight. On the day of the test all steaks were pierced with a six-pronged ice chipper 30 times before and 60 times after addition of the enzyme solution. This procedure was repeated on the other side, and the steaks were returned to the refrigerator. Forty-five minutes after treatment the steaks were put 3 inches below the heating unit of an electric broiler in a household-type range. The steaks were broiled for 8 minutes on the first side and 7 minutes on the second.

In the 10 days of testing, two sets of samples were served to judges at each testing session. The first set of samples included untreated control I, low-enzyme, and alkaline-low-enzyme; the second set included untreated control II, high-enzyme, and alkaline-high-enzyme. Controls were not identified to the panel members, and each sample was evaluated independently. Presentation of samples on two plates was necessary for control of food quality and preparation procedure and was basic to neither design of the experiment nor analysis of the results.

The time interval between testing of the first set of samples and second set was 15 to 18 minutes. The randomly coded samples for each panel member were always cut from the same location in the steak and were served on heated plates. Two cores, one from near the center and one from the outside edge, were reserved from each steak for shear testing.

Evaluation of Samples. Palatability was evaluated by six homemakers who received three days of preliminary experience and who had served six days on a panel not reported here. The panel members judged the meat for tenderness, flavor, juiciness, texture, and general acceptability. Judges rated samples by using the following scale: 5, very desirable; 4, desirable; 3, acceptable; 2, slightly undesirable; and 1, undesirable.

Objective measurements for this study were obtained by using the Warner-Bratzler shearing apparatus. All cooked samples of meat were allowed to come to room temperature before they were sheared.

Statistical evaluation consisted of analysis of variance using a mixed model (Snedecor, 1956) with treatments regarded as the fixed variable. When the treatment means differed significantly, Tukey's test (Duncan, 1959) was used for comparison. As previously explained, one round of beef was used in one day; therefore, the factor of replication necessarily included both animal differences and differences among days if such occurred.

RESULTS AND DISCUSSION

For all characteristics, mean scores were higher for treated samples than for untreated controls, and the differences were significant for juiciness and flavor (Table 1). Analysis of variance, however, failed to show any significant effects for treatments in the case of tenderness, texture, or general acceptability (Table 2).

As indicated by mean scores (Table 1) all samples of meat were judged acceptable in each palatability characteristic and in general acceptability, except for tenderness of controls I and II. In the latter case, the scores were 2.95 and 2.84 for tenderness, whereas a score of 3 would have indicated an acceptable quality according to the descriptions assigned to numerical values on the score card.

It is possible that the NaCl influenced the tenderness ratings. As pointed out by Wang *et al.* (1958) in their investigation of enzymatic action on meat, 2% NaCl in the rehydrating media markedly increased tenderness. These findings, along with results of exploratory work on flavor, were responsible for the decision to use salt as one of the additives.

In the study reported herein, mean values showed that samples were rated in the same order by both panel and shear tests when compared with their own controls (Tables 1 and 3). However, a difference of opinion exists among researchers as to whether panel tests for tenderness and shearing measure the same quality. Deatherage and Garnatz (1952) stated that synonymous use of the term "shear strength" as determined by the Warner-Bratzler instrument and the ten-

TABLE 1-COMPARISON OF MEANS[1] OF PANEL SCORES[2] FOR TREATED AND UNTREATED U.S. STANDARD GRADE ROUND OF BEEF (60 OBSERVATIONS FOR EACH TREATMENT)

Treatment	Tenderness	Texture	Juiciness	Flavor	General Acceptability
Control I	2.95	3.17	3.13^{a}	3.32^{a}	3.00
Control II	2.84	3.20	3.06^{a}	$3.52^{a,b}$	3.06
Low-enzyme[3]	3.33	3.34	3.65^{b}	$3.65^{a,b}$	3.41
Alkaline-low-enzyme[3, 5]	3.51	3.53	3.84^{b}	3.77^{b}	3.60
High-enzyme[4]	3.76	3.45	3.99^{b}	$3.54^{a,b}$	3.53
Alkaline-high-enzyme[4, 5]	3.60	3.37	3.77^{b}	$3.57^{a,b}$	3.43

[1]Tuckey's test (Duncan 1959). Where exponent letters differ within a column, mean scores differ significantly (5% level) from each other. Exponent letters have no meaning in themselves. Significant differences occured only in juiciness and flavor.

[2]Range of scoring: 1, undesirable; 2, slightly undesirable; 3, acceptable; 4, desirable; 5, very desirable.

[3]The equivalent of $\frac{1}{4}$ teaspoon enzyme per pound of meat.

[4]The equivalent of $\frac{1}{2}$ teaspoon enzyme per pound of meat.

[5]pH adjusted to approximately 7.3.

TABLE 2-ANALYSIS OF VARIANCE[1] OF FACTORS INFLUENCING CHARACTERISTICS OF U.S. STANDARD GRADE ROUND OF BEEF TREATED WITH DIFFERENT LEVELS OF PANCREATIC ENZYMES

Sources of Variation	d.f.	Tenderness F Value	Texture F Value	Juiciness F Value	Flavor F Value	General Acceptability F Value
Treatments[2]	5	1.04	0.65	3.43*	3.25**	1.11
Animals	9	1.39	1.57	1.60	2.11*	1.45
Judges	5	2.27	1.46	2.40	5.61***	4.65**
Animals x treatments	45	4.24***	1.18	2.90***	1.15	1.69*
Animals x judges	45	3.43***	2.59***	2.17**	2.00**	1.69*
Treatments x judges	25	4.50***	4.91***	2.63***	2.75***	1.88*

[1]Snedecor (1956).
[2]Untreated controls, low-enzyme (equivalent of $\frac{1}{4}$ tspn enzyme/lb meat), high-enzyme (equivalent of $\frac{1}{2}$ tspn enzyme/lb meat), and alkaline-low-enzyme and alkaline-high-enzyme (pH adjusted to approximately 7.3).
*Significant at 5% level.
**Significant at 1% level.
***Significant at 0.1% level.

TABLE 3-SHEAR VALUES[1] FOR TWO CORE POSITIONS OF U.S. STANDARD GRADE OF ROUND OF BEEF

Treatment	Core 1		Core 2		Mean of Cores
	Range	Mean	Range	Mean	
	lb	lb	lb	lb	lb
Control I (untreated)	16.25-43.75	25.36	20.00-49.00	30.73	28.04
Low-enzyme[2]	15.75-37.25	27.18	12.00-50.00	27.68	27.43
Alkaline-low-enzyme[2,4]	16.00-30.25	24.58	16.50-35.00	26.75	25.66
Control II (untreated)	17.00-35.50	27.13	20.50-43.75	31.75	29.44
High-enzyme[3]	16.75-31.75	26.03	16.00-43.50	27.83	26.93
Alkaline-high-enzyme[3,4]	20.50-39.25	28.23	15.50-50.25	28.23	28.23

[1]Warner-Bratzler shear values for 1-inch cores.
[2]The equivalent of $\frac{1}{4}$ tspn enzyme/lb meat.
[3]The equivalent of $\frac{1}{2}$ tspn enzyme/lb meat.
[4]pH adjusted to approximately 7.3.

derness of meat should be avoided. On the other hand, Schoman *et al.* (1960) indicated that the best known mechanical methods of measuring meat tenderness still include the Warner-Bratzler shear.

The differences in mean shear values due to treatment were not significant (Table 4) and there was a wide range among replications. The effect of position of shear sample was significant at the 5% level. The mean shear values among treated and untreated samples ranged from 25.66 for alkaline-low-enzyme treatment to 29.44, for control II samples (Table 3).

Exploratory investigations revealed that a liver-like appearance accompanied by some sloughing occurred on meat treated with high levels of enzyme concentration. Therefore, it seemed important to include the characteristic of texture on the score sheet. The range of means obtained for texture was 3.17 to 3.53 (Table 2). As indicated by mean scores, all samples were acceptable in this characteristic and treated samples were scored higher than the controls.

All treated samples of meat were rated significantly higher in juiciness than controls (Table 1). Treatments ranked in order of decreasing means for juiciness were high-enzyme, alkaline-low-enzyme, alkaline-high-enzyme, low-enzyme, control I, and control II. Related exploratory work on cooking losses did not appear to support the thesis that the apparent increase in juiciness was due to retention of meat juices. The increase in juiciness of meat treated with animal enzyme differed from the results of Hay *et al.* (1953). Those authors reported that juiciness scores were significantly higher for untreated broiled top round steaks than for steaks treated with the vegetable enzyme papain.

The range of mean scores for flavor of the steaks was from 3.32 for control I to 3.77 for alkaline-low-enzyme treatment (Table 1). The only significant flavor difference was between control I and alkaline-low-enzyme treated samples. Differences in flavor preference among judges contributed to the high basic variation in scores for this attribute.

TABLE 4-ANALYSIS OF VARIANCE[1] OF SHEAR VALUES OF U.S. STANDARD GRADE ROUND OF BEEF TREATED WITH DIFFERENT LEVELS OF PANCREATIC ENZYME

Source of Variation	d.f.	F Value
Treatments[2]	5	0.83
Animals	9	6.39***
Position of cores	1	4.42*
Animals x treatments	45	1.28
Treatments x position of cores	5	0.60
Animals x position of cores	9	0.74

[1]Snedecor (1956).

[2]Range of scoring: 1, undesirable; 2, slightly undesirable; 3, acceptable; 4, desirable; 5, very desirable.

*Significant at 5% level.

***Significant at 0.1% level.

Much of the variation of general acceptability was due to the effect of judges (Table 2). The effects of treatments and of animals were not significant although all interactions were significant at the 5% level. As indicated by means, the panel rated all treated samples higher than controls in general acceptability (Table 1).

When pH was adjusted by addition of sodium bicarbonate, higher means for all attributes resulted at the low level of enzyme concentration. However, at the high levels of enzyme concentration, mean scores were slightly lower for all attributes except flavor when the pH was raised.

It is of interest to note that the desiccated pancreas preparation used in this study was relatively expensive. Therefore, further study of the relation between pH, length and temperature of treatment, and enzyme concentration might indicate use of lesser amounts of such a tenderizer with appropriate adjustments.

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