MECHANICALLY TENDERIZED BEEF

HERBERT W. OCKERMAN, RODNEY F. PLIMPTON, VERN R. CAHILL and KEITH J. BOYD

The Ohio State University, Columbus, Ohio 43210, and The Ohio Agricultural Research and Development Center, Wooster, Ohio 44691, U.S.A.

USDA good grade semimembranosus beef muscle was passed 0 (control), 1, 2 and 4 times through a mechanical tenderizer consisting of 3 mm X 0.008 mm blades which resulted in a penetration density of approximately 3 per square cm. The beef tissue was vacuum packaged and stored at 2°C for one day, 2 and 4 weeks. After oven-roasting to a 67°C internal temperature, the mechanically tenderized beef was initially found to be significantly ($P<.01$) more tender, less juicy and rated higher on overall acceptability. The cooking rate was more rapid ($P<.01$) for the tenderized samples and resulted in a higher ($P<.01$) cooking drip and approached a significantly higher ($P>.05$) total cooking loss. Bacterial contamination was greater ($P<.05$) for the treated samples. Texture was noticeably more fragile for the product tenderized four times. Two weeks storage increased the tenderization of all samples. The non-treated samples were, after two weeks storage, at the same level of tenderness as the samples which were passed one time through the mechanical tenderizer at one day storage time. All samples decreased in flavor with storage; however, the tenderized samples decreased more rapidly than the control. These same trends continued for the four weeks storage period. From these results it seems desirable to mechanically tenderize good grade beef rounds by one pass through a mechanical tenderizer if refrigerated storage is to be less than 10 days. If longer storage is anticipated, mechanical tenderization does not seem appropriate due to the increased chances of bacterial contamination and decreased juiciness and flavor of the tenderized items.

VIANDE DE BOEUF ATTENDRIE A LA MACHINE

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Un muscle semimembraneux de boeuf provenant de viande USDA de bonne qualité a été passé 0 (contrôle), 1, 2, et 4 fois à travers un attendrisseur mécanique à lames de 3 mm X 0,008 ayant une densité de pénétration d'environ 3 par centimètre carré. On a mis la viande dans un paquet sous vide et on l'a emmagasinée à 2°C pour un jour, 2 semaines et 4 semaines. Après l'avoir rôtie dans un four à une température interne de 67°C, la viande attendrie mécaniquement était sensiblement plus tendre ($P<.01$), contenait moins de jus et a été estimée dans l'ensemble de meilleure qualité. Le temps de cuisson était plus rapide ($P<.01$) pour les spécimens attendris. En conséquence, la perte de liquide par égouttement était supérieure ($P<.01$) ce qui avoisinait une perte totale de cuisson sensiblement plus élevée ($p>.05$). La contamination de bactères était supérieure ($P<.05$) dans les spécimens traîtés. La texture était plus fragile dans le produit attendri 4 fois. Deux semaines d'emmagasinage a augmenté l'attendrissage de tous les spécimen. Les spécimens non-attendris étaient, après 2 semaines, aussi tendres que ceux-attendris 1 fois à la machine après un jour d'emmagasinage. On a constaté une diminution dans le goût avec l'emmagasinage; les spécimens attendris ont montré une perte en goût plus rapide que ceux de contrôle. Les mêmes tendances se sont vérifiées pendant toutes les 4 semaines. D'après ces résultats, il semble désirable d'attendrir à la machine les tranches de boeuf de bonne qualité en les faisant passer 1 fois par l'attendrisseur mécanique si cette viande est gardée moins de 10 jours. Si on prévoit un emmagasinage plus prolongé, il ne semble pas approprié d'employer l'attendrisseur mécanique à cause de l'augmentation dans l'éventualité de contamination de bactères, d'une diminution du jus et du goût dans les spécimens attendris.

MASCHINELL WEICHGEMACHTES FLEISCH

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ГОВЯДИНА, ОТБИТАЯ (СМЯГЧЕННАЯ), МЕХАНИЧЕСКИМ СПОСОБОМ

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Говяжий мускул из верхней части бедра, сорт "хороший" министерства сельского хозяйства Соединенных Штатов, был пропущен 0 (контроль), 1, 2, 3 и 4 раза через механический отбиватель, состоящий из 3 мм х 0, 008 мм лопастей, в результате чего получилась плотность проникновения приблизительно 3 на $см^2$. Говяжья ткань была герметически запакована и хранилась при температуре 2°С один день, 2 и 4 недели. После жарки в духовке до внутренней температуры 67°С, отбитая механическим способом говядина оказалась значительно (Р - вероятность $< 0,01$) более мягкой, менее сочной и получила более высокую оценку в отношении общей приемлемости. Жарка отбитых проб происходила быстрее ($P < 0,01$), истекание при жарке было большее и приблизилось к значительно более высокой общей потере при жарке ($P > 0,05$). Бактериальное заражение для отбитых проб было выше ($P < 0,05$). Консистенция была значительно более ломкой в продукте, отбитом четыре раза. Необработанные пробы были, после двух недель хранения, на таком же уровне мягкости, как пробы, которые прошли один раз через механический отбиватель при одном дне хранения. Все пробы теряли часть вкуса при хранении, однако, отбитые пробы теряли вкус быстрее, чем пробы. Такие же самые тенденции продолжались в течение четырех недель хранения. На основании полученных данных можно считать, что желательно производить механическое отбивание говядины хорошего качества от верхней части бедра, пропуская её один раз через механический отбиватель, если замороженное хранение будет продолжаться не больше 10 дней. Если предполагается более длительное хранение, механическое отбивание не является подходящим ввиду более высокой вероятности бактериального заражения и уменьшения сочности и вкуса отбитых изделий.

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INTRODUCTION

Tenderness of fresh meat is the primary factor associated with consumer acceptance (Carpenter, 1975). Aging of beef carcasses has traditionally been the most common method employed to improve tenderness (Davis et al., 1975). Aging of beef in vacuum has recently become popular and has been shown to decrease moisture loss and retard microbiological growth (Davis et al., 1975; Hodges et al., 1974). During the last decade, mechanical tenderization has gained acceptance and now it is estimated that over 90% of all hotel, restaurant and institutions use meat treated in this manner (Carpenter, 1975; Miller, 1975).

PROCEDURE

The experimental design of this project involved 4 mechanical tenderization treatments [0(Control), 1, 2 and 4 times through the mechanical tenderizer] and 3 storage intervals (1 day, 2 and 4 weeks). The experiment was repeated 5 times. The semimembranosus muscles from 15 USDA good grade beef carcasses were used and each tenderization treatment was applied to ½ of a semimembranosus muscle (2.25 to 2.50 kilograms) so that each treatment was applied to every carcass.

A tenderization treatment was passing a muscle section through a mechanical tenderizer consisting of 3 mm X 0.008 mm blades driven by a limiting force of 1.5 kilogram per blade which resulted in a penetration density of approximately 3 blades per square centimeter. After the tenderization treatments, the muscles were vacuum packaged and stored at 2°C for one day, 2 and 4 weeks.

The samples were evaluated for weight loss during refrigerated storage; subjective color and odor by a sensory panel immediately upon opening and 15 minutes later; color by reflectance at 685 millimicrons (Ockerman and Cahill, 1969); and, aerobic (Tryptone Glucose Extract Agar, at 25°C) and anaerobic (BBL anaerobic agar, H^+ and CO_2 gas generators, 35°C) bacterial numbers (Ockerman, 1974). After oven roasting to an internal temperature of 67°C samples were evaluated for cooking rate, total cooking loss, cooking drip, cooking evaporation, tenderness using the Warner-Bratzler shear on a 2.5 cm core, TBA values (Ockerman, 1974) and sensory panel evaluation for juiciness, flavor, tenderness and overall acceptability using a 10-point hedonic scale with 10 being desirable and 1 undesirable. The results were analyzed using the Least Squares Maximum Likelihood General Purpose Program (Harvey, 1968) in addition to Duncan's Multiple Range test.

RESULTS AND DISCUSSION

During 2°C vacuum storage no evaporation occurred; however, a linear ($P<.01$) increase in drip loss (Fig. 1) was observed which averaged 5% at the 4 weeks storage time. There was no significant difference in drip between the control and any of the treatments. This agrees with Huffman (1975) but disagrees with the Carpenter report (1975) on beef stored 14 days.

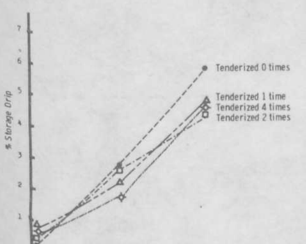

Fig. 1. Effect of tenderization treatments on percentage storage drip loss.

A significant ($P<.05$) linear decrease (lightening) in intensity of color over storage time was observed for samples evaluated immediately upon removal from vacuum storage as well as 15 minutes after removal. The correlation between the initial and 15 minute period observations was 0.91. A correlation of -0.64 was obtained between panel color scores and reflectance readings. The panel gave non-significant ($P>.05$) lighter scores to the tenderized samples.

A panel fresh odor evaluation was also completed when the packages were opened and 15 minutes later (see Fig. 2). Odor scores became significantly ($P<.01$) less desirable as storage time increased for both the 0 and 15 minutes evaluation periods. Odor scores for mechanically tenderized samples were significantly less desirable than the control. Correlation values of 0.65 and 0.58 were obtained between 15 minute odor evaluation scores and aerobic and anaerobic microbiological counts. The 15 minute raw odor evaluations were also significantly ($P<.01$) correlated with cooked sensory panel flavor evaluations (r=0.61) as well as overall cooked taste panel acceptability (r=0.38).

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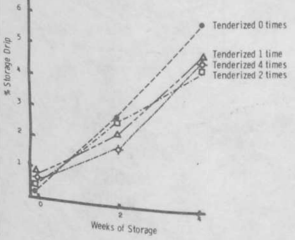

Fig. 1. Effect of tenderization treatments on percentage storage drip loss.

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Both aerobic (see Fig. 3) and anaerobic (see Fig. 4) bacterial numbers increased for 2 weeks and then decreased between week 2 and 4 which resulted in a significant ($P<.01$) quadratic growth curve. The samples tenderized one time had greater bacterial numbers than the control; however, this difference was not significant ($P>.05$). The samples tenderized 2 and 4 times, however, had bacterial counts that were significantly ($P<.05$) higher than the control.

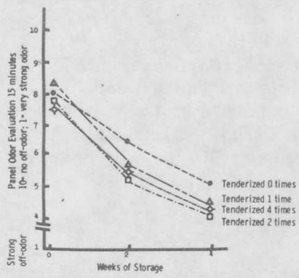

Fig. 2. Effect of tenderization treatments on panel odor evaluations during storage.

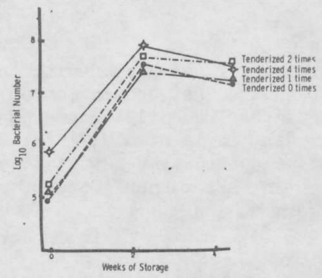

Fig. 3. Effect of tenderization treatments on aerobic bacterial growth during storage.

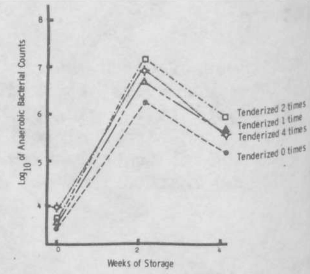

Fig. 4. Effect of tenderization treatments on anaerobic bacterial growth during storage.

The cooking rate (see Fig. 5) for samples which were mechanically tenderized was faster with each additional pass through the tenderizer but only the sample tenderized 4 times cooked significantly ($P<.01$) faster than the untreated sample. Several researchers (Goldner and Mandigo, 1974; Schwartz and Mandigo, 1974; Davis et al., 1975; and, Judge et al., 1975) have reported increased cooking rates with mechanical tenderization.

Total cooking loss (see Fig. 6) was greater for the tenderized than the control samples at each of the 3 storage periods. This difference approached but did not reach a significant level ($P>.05$). Cooking drip loss (see Fig. 7) was significantly ($P<.01$) greater for the samples tenderized 4 times when compared to the samples tenderized 0, 1 and 2 times. The sample tenderized 4 times, however, had a smaller evaporation loss (see Fig. 8) than the other treatments.

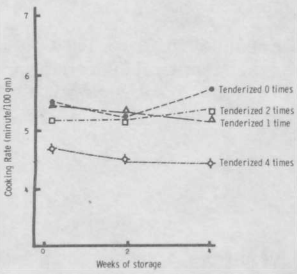

Fig. 5. Effect of tenderization treatments on cooking rate during storage.

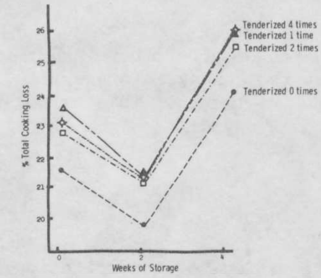

Fig. 6. Effect of tenderization treatments on % total cooking losses during storage.

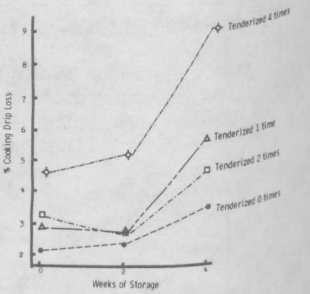

Fig. 7. Effect of tenderization treatments on % cooking loss by drip during storage.

A sensory panel evaluated each product at each storage interval for juiciness, flavor, tenderness and overall acceptability (see Fig. 9, 10, 11 and 12).

Values for sensory panel juiciness remained relatively constant for the control sample during the 4 weeks of storage. Values for the treated samples were lower initially and decreased more rapidly during storage which resulted in a significant difference ($P<.01$) between the tenderized and the control samples. Juiciness values were significantly correlated ($r= -0.45$) with total cooking losses. Decrease in juiciness due to mechanical tenderization has also been reported by several other research workers (Judge et al., 1975; Petersohn et al., 1976; and Davis et al., 1975).

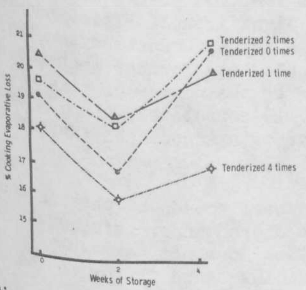

Fig. 8. Effect of tenderization treatments on % cooking loss by evaporation during storage.

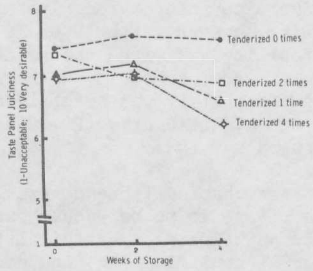

Fig. 9. Effect of tenderization treatments on juiciness during storage as measured by taste panel.

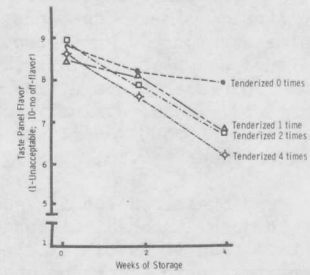

Fig. 10. Effect of tenderization treatments on flavor during storage as measured by taste panel.

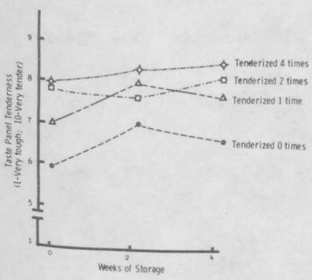

Fig. 11. Effect of tenderization treatments on tenderness during storage as measured by taste panel.

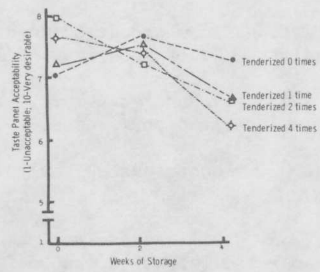

Fig. 12. Effect of tenderization treatments on acceptability during storage as measured by taste panel.

All samples were initially rated high for flavor desirability; however, there was a significant ($P < .01$) linear decrease in this factor as storage time increased. The flavor of tenderized samples decreased at a more rapid rate than the control which resulted in a significant ($P < .05$) difference due to treatment. At both the 2 and 4 week testing periods, samples were ranked in order of number of times tenderized. Other workers have not found this decrease in flavor; however, in all cases their storage time did not exceed 16 days. A highly significant ($P < .01$) correlation was observed between panel flavor evaluation and aerobic ($r = 0.49$) and anaerobic ($r = 0.37$) bacterial numbers.

Sensory panel evaluation for tenderness was found to have a significant ($P < .01$) F-statistic for the mechanical treatment effect. The tenderized samples were rated more tender than the control sample at each storage interval. At the end of two weeks of storage, tenderness scores were more acceptable for all samples. The non-treated samples were, after two weeks storage, at the same level of tenderness as the samples passed one time through the mechanical tenderizer at one day of storage. Samples tenderized one time were significantly ($P < .01$) more tender than the control. Additional passes through the tenderizer resulted in further tenderization with samples receiving four passes being significantly ($P < .01$) more tender than the samples tenderized one time. Sensory panel tenderness was significantly ($P < .01$) correlated with values obtained from the Warner-Bratzler shear test ($r = -0.73$). See Fig. 13. These results agree with the work of Judge et al., 1975, and Carpenter, 1975, in that lower quality beef grades will receive higher panel tenderness scores when mechanically tenderized.

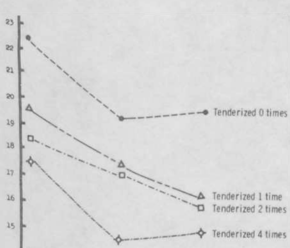

Fig. 13. Effect of tenderization treatments on Warner-Bratzler Shear Force during storage.

Texture was noticeably more fragile for the samples tenderized four times. These same samples had a flattened shape perpendicular to the direction of knife travel.

Sensory panel evaluation for overall acceptability indicated a significant (P<.05) quadratic change over storage time. The tenderization-storage time interaction also approached significance. The tenderized samples were judged more acceptable initially; however, after 2 weeks of storage the untenderized samples were more acceptable. This shift in acceptability away from the tenderized samples was further emphasized at the four-week storage time when the samples were ranked in the reverse order to the number of times tenderized. Panel evaluation for overall acceptability was significantly (P<.01) correlated with juiciness (r=0.60) and flavor (r=0.76) but not significantly (P>.05) correlated with tenderness (Warner-Bratzler shear r=0.08; sensory panel tenderness r=0.14).

From these results it seems desirable to mechanically tenderize good grade beef rounds by passing one time through a mechanical tenderizer if the tissue is to be vacuum packaged and stored under refrigeration for less than 10 days. If longer storage is anticipated, mechanical tenderization does not seem appropriate due to increased chances of bacterial contamination, and decreased juiciness and flavor of the tenderized samples.

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