EFFECT OF GINGER RHIZOME EXTRACT ON TENDERNESS AND SHELF LIFE OF PRECOOKED LEAN BEEF

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Summary

The inclusion of crude ginger rhizome (*zingiber officinale*) extract at 0.5 to 1.0% (v/w) in the marination of marginally acceptable lean beef improved meat tenderness by 20-30% in the absence of 2% salt and by 35-45% in the presence of 2% salt. Ginger extract also retarded the development of rancidity and increased shelf-life of precooked lean beef two-fold in saran-wrap (no vacuum) storage at 4℃. Ginger rhizome improves the palatability and acceptability of lean beef from carcasses of marginal quality. It is particularly beneficial for the preparation of pre-cooked ready-to-eat beef products that are not vacuum-packaged.

(**Key Words** : Lean Beef, Ginger Rhizome, Tenderness, 2-Thiobarbituric acid, Antioxidant)

Introduction

In response to the pressure of "lean-conscious society", the beef industry is forced to focus on producing and effectively marketing lean beef and work to associate beef with active life-style and healthful living. However, a survey shows that consumers also place a high priority on taste or palatability when purchasing beef (AMI, 1987), and a certain amount of fat is needed for acceptable palatability. Savell and Cross (1988) reported that 3% chemical fat or slight marbling was the minimum level of fat needed for acceptable palatability for beef cuts from the rib and loin. One way of marketing lean beef without jeopardizing acceptable palatability is to modify the preparation and cookery methods. In oriental countries where old draft cattle were used for food, marination and cooking of thinly sliced beef was extensively employed for many centuries. Marination improves the palatability of marginally acceptable meat, and the recent trend shows increased marketing of ready-to-cook marinated meat products in retail stores.

One ingredinet that has been used in marinated beef is ginger rhizome (*zingiber officinale*). Application of 0.5~1.0% (v/w) crude ginger extract greatly enhanced the tenderness of beef steaks and sliced beef (Lee et al., 1986a). Ginger rhizome also was reported to contain a potent antioxidant activity against heme-catalyzed lipid oxidation and extend the shelf life of fresh or precooked pork patties by three times at 4℃ storage temperature (Lee et al., 1986b). Improvement of tenderness and retardation of fat oxidation indicates the usefulness of ginger rhizome in marinated ready-to-cook lean beef or precooked convenience beef products.

The objective of this study was to investigate the effectiveness of ginger rhizome on meat tenderness and shelf life of precooked lean beef from carcasses of marginal quality.

Materials and Methods

Ginger extract

Fresh ginger rhizome was purchased from a local supermarket. The rhizome was peeled, sliced, ground in a mortar with pestle, and squeezed through four layers of cheesecloth to produce a crude ginger extract. The yield of crude extract was approximately 50% of the peeled rhizome weight.

Preparation and treatment of beef

Loin eye muscle from a B maturity, select grade steer was sliced 4 mm thick, divided into 8 lots and treated as shown in table 1. Meat samples were uniformly mixed with the appropriate solution of ingredients, held at 4℃ for 1 hr, spread on a tray and broiled for approximately 4

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min until no pink color was visible. Cooked meat samples of each treatment were either wrapped with Saran-wrap (no vacuum) or vacuum-packaged and stored in a refrigerator of 4℃.

TABLE 1. EXPERIMENTAL DESIGN

Treatments	Sliced meat (g)	Ginger extract (ml)	Salt (g)	Water (ml)
T_1	500	0	0	15
T_2	500	2.5	0	12.5
T_3	500	5.0	0	10.0
T_4	500	7.5	0	7.5
T_5	500	0	10	15
T_6	500	2.5	10	12.5
T_7	500	5.0	10	10.0
T_8	500	7.5	10	7.5

Storage test

Rancidity test using 2-thiobarbituric acid (TBA) method as described by Tarladgis et al. (1960) and microbiological assay using standard plate count method (Clark et al., 1987) were performed on duplicate samples taken at 0, 2, 5, 8 and 12 days for Saran-wrap samples and at 0, 7, 14, 28, 35 and 47 days for vacuum-packaged samples. The TBA number was expressed as mg malonaldehyde per kg meat.

Tenderness test

Tenderness of broiled meat samples was determined using Lee-Kramer (LK) shear measurement as described by Lee (1983).

Statistical analysis

Data were analyzed by analysis of variance with the BLM procedure of SAS (1982).

Results and Discussion

Effect of salt and ginger extract on meat tenderness

The treatment of meat slices with 0.5% (v/w) crude ginger extract decreased ($p < 0.05$) shear value of the cooked meat by 20% in the presence or absence of salt in the formulation (table 2). Further decrease of shear values was observed at higher concentrations of ginger extract, approximately 30 and 45% decrease at 1.0 and 1.5%. The inclusion of 2% salt alone decreased shear value by 20%. Tenderness improvement effect of salt and ginger extract was additive at all levels of extract, indicating that the ginger protease activity was not affected by the presence of salt. In the presence of 2% salt, 0.5% ginger extract was sufficient for acceptable tenderness, whereas 1.0% extract was recommendable in the absence of salt. In both cases, a 30% reduction in shear value was obtained compared with untreated controls. When crude extract exceeded 1.0% level, meat texture became overly soft and was unacceptable.

TABLE 2. EFFECT OF GINGER EXTRACT ON MEAT TENDERNESS

Treatments	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
L-K shear value, Kg/20 g meat	140^a	113^b	101^c	75^d	112^b	90^e	79^d	60^f
Relative difference	100	81	72	54	80	64	56	43
	–	–	–	–	100	80	71	54

Each mean represents duplicate determinations.

Mean with different superscripts differ significantly at $p < 0.05$.

Relative difference was calculated against T_1, (first row) and T_5 (second row).

One of the factors affecting the tenderization effect of ginger extract is pH. Jung (1992) and Thompson et al. (1973) reported the pH range of 5.0~6.0 for optimal proteolytic activity, which would be ideal for use in meat marinades or for treatment of fresh meat since these would normally fall within this pH range. The pH of meat used in this study was 5.68. Another minor factor is the length of holding time before cooking. Because the proteolytic enzyme in ginger has an optimum temperature of 60℃, the major portion of tenderization occurs during cooking. Nonetheless, holding the marinated meat for an extended period of time at a cooler temperature of 4℃ further increases meat tenderness. In this study, one-hour holding time was used to hold the marinades long enough for the uniform penetration and distribution of ginger extract in the marinated meat.

Changes of TBA values during storage

There was a rapid increase of TBA number during the first 5 days of storage of the cooked meat, followed by a slower rate regardless of treatments (table 3). However, a marked difference was observed in the rate of increase among treatments, T_1 and T_5 (0% extract) showing two

times greater rate than T_4 and T_8 (1.5% extract) during the first 5 days of storage. At 0.5 to 1.0% crude extract which was the optimal level for tenderization without causing mushiness, it took 12 days to reach a TBA value of 7.0 compared with 5 days for untreated controls. The presence of salt did not appear to accelerate oxidation rate in the present study. The results demonstrated that ginger extract was effective in retarding the development of rancidity in precooked beef, and its effectiveness was directly related to the concentration.

TABLE 3. CHANGES IN TBA VALUE DURING REFRIGERATED STORAGE OF SARAN-WRAPPED, COOKED MEAT SLICES

Treatments	Storage period, days				
	0	2	5	8	12
T_1	0.5^a	3.7^a	7.1^a	8.1^a	8.6^a
T_2	0.3^{ab}	2.2^b	5.8^b	6.9^b	7.4^b
T_3	0.1^b	1.7^{bc}	5.0^b	6.3^{bc}	7.4^b
T_4	0.1^b	1.3^c	3.8^c	5.4^c	6.4^c
T_5	0.4^a	3.8^a	7.4^a	8.2^a	8.7^a
T_6	0.3^{ab}	2.8^b	5.8^b	6.6^b	6.9^b
T_7	0.2^b	2.4^{bc}	4.8^b	5.6^c	6.8^b
T_8	0.2^b	1.8^c	3.2^c	4.6^d	5.7^c

Each mean represents duplicate determinations.

Means with different superscript in the same column differ significantly at $p < 0.05$.

Lee et al. (1986) also reported similar results in pork patties. The inclusion of 0.5% extract in fresh or precooked pork patties retarded the rate of TBA value increase by 2.5 to 3 times compared with untreated controls. Poste et al. (1986) reported a rapid increase of TBA value in precooked pork during the first 4 days of storage at 4℃ followed by a small increase between 4 and 16 days. The off-aroma scores by trained panel correlated well with the TBA values during the first 8 days of storage. Because off-flavor is the major factor affecting the shelf-life of precooked meat products, the inclusion of ginger extract can extend the shelf-life by at least two times.

For vacuum-packaged beef (table 4), the TBA values increased very slowly during 47 days of storage for all treatments. Though ginger extract at greater than 1.0% level tended to lower TBA values, the differences among treatments were low in magnitude and nonsignificant.

TABLE 4. CHANGES IN TBA VALUE DURING REFRIGERATED STORAGE OF VACUUM-PACKAGED, COOKED MEAT SLICES

Treatments	Storage period, days				
	7	14	28	35	47
T_1	0.8	0.8	1.5	2.0	2.3
T_2	0.7	0.8	1.6	2.1	2.1
T_3	0.6	0.7	1.4	1.6	1.8
T_4	0.5	0.8	1.4	1.6	1.6
T_5	0.6	0.9	1.5	2.0	2.1
T_6	0.8	1.2	1.7	2.3	2.2
T_7	0.8	0.7	1.1	1.4	1.8
T_8	0.5	0.7	1.4	1.4	1.5

Each mean represents duplicate determinations.

Microbiological changes during storage

No systematic increase of total bacteria counts or spoilage was detected during the storage periods for both Saran-wrap or vacuum-packaged beef samples. The inclusion of ginger extract did not pose any microbiological safety problems.

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