Evaluation of antioxidant effects of Garam Masala and Chinese 5-Spice ingredients

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Introduction

Garam masala and Chinese 5-spice are widely used in Asian cuisine including curries, rice dishes and various cooked meat products. Lipid oxidation is a major source of muscle food degradation and leads to production of malonaldehyde, a potent mutagen / carcinogen.

Spices such as cloves, cinnamon, black pepper, turmeric, ginger, garlic and onions exhibit antioxidant properties in different food systems (Younathan et al., 1980; Al-Jalay et al., 1987; Jurdi-Haldeman et al., 1987). However, Garam Masala and Chinese 5-Spice have not been specifically tested in cooked ground beef. It is also of interest to determine which spice ingredients have the greatest antioxidant activity in these traditional spice blends.

Objectives

To compare the antioxidant properties of Garam Masala and Chinese 5-Spice blends and their individual ingredients in cooked ground beef. We also formulated USU spice blends for Garam Masala and Chinese 5-Spice, using the optimum levels of each individual spice, and compared them with the retail blends for aerobic plate count during 15 days storage of cooked ground beef at 2¡C. Sensory flavor profile was also done on cooked ground beef containing the various spices at their optimum antioxidant level.

Procedures

Sample Preparation - Individual ingredients (13 ingredients in Garam Masala and 5 in Chinese 5-Spice) were each manually mixed at 0.1, 0.5 and 1.0% levels in lean raw ground beef (15% fat). Samples (100 g) with added ingredients were thoroughly cooked at 163¡C for 5 min., placed in re-sealable plastic bags, cooled for 10-15 min. at room temperature and stored for 1, 8 or 15 days at 2¡C. Thiobarbituric acid (TBA) values were measured in duplicate at 1, 8 or 15 days on the cooked samples as an indicator of oxidative rancidity. For each ingredient the experiment was replicated three times.

TBA Value - Thiobarbituric acid reactive substances (TBARS) assay was performed as described by Buege and Aust (1978). Duplicate samples for all the treatments were mixed with 2.5 ml of stock solution containing 0.375% TBA, 15% TCA and 0.25 N HCl. The absorbance of the supernatant was measured spectrophotometrically at 532 nm.

1) TBA # (mg/ kg) = Sample A_{532} x (1 M TBA Chromagen / 156,000) x [(1 mole / L) / M] x (0.003 L / 0.5 g meat) x (72.07 g MDA / mole MDA) x (1000 g / Kg), or

2) TBA # (ppm)= Sample A_{532} x 2.77. (where, MDA = malonaldehyde).

Sensory Flavor Profile - Sensory evaluation was done on Day 0 samples after cooking each individual meat sample with the optimum content of each spice as determined in our first experiment. Panelists (15) evaluated the samples containing spices for detectable spice flavor, whether the spice flavor was desirable or not, and they were also asked to comment on the specific flavor attributes of each sample.

Aerobic Plate Count - Aerobic plate counts were carried out for the different spice blends (USU Garam Masala, USU 5-Spice, Retail Garam Masala, and Retail Chinese 5-Spice) using standard plate count procedures. The serial dilutions were made in duplicate for each sample and the plates were incubated at 37¡C for 48 hours prior to counting of colonies.

Results

All spices had significant antioxidant properties compared to control samples (Table 1-2). Control cooked ground beef samples were highly rancid after 15 days storage, with TBA no. >3.0 (Table 1-2). Clove was the most potent antioxidant. Clove powder (0.1%) yielded TBA values of <1.0 after 15 days storage of cooked ground beef. Cardamom and caraway were the least effective antioxidant spices, with an optimum usage level of 1.0%. All other spices were as effective at 0.5% as 1.0%. Thus, their optimum usage level was 0.5%. (Table 1-2).

Fig. 1-2 show the mean TBA values for each spice at its optimum level (0.1, 0.5 or 1.0%) in cooked ground beef. Optimum level of coriander (0.5%) gave mean TBA values that were significantly higher than cinnamon, clove and ginger (Fig. 1). Individual spices of Chinese 5-Spice were not different from each other but were different ($p<0.05$) from controls (Fig. 2).

For retail Garam Masala, the lowest TBA values were found at the 1% level (Table 3a), but for retail Chinese 5-Spice, the lowest TBA values were found at the 0.5% level (Table 3b). However, for both blends 0.5 and 1.0 % levels were not significantly different.

USU Garam Masala and Chinese 5-Spice blends were formulated using the optimum level of individual spices as determined from data in Table 1. The USU Garam Masala was added to meat at 1.0% level and USU Chinese 5-Spice was added at 0.5% of meat weight as determined in Table 3a. There was no significant difference in the TBA values among samples formulated with retail or USU spice blends (Table 3b).

Sensory flavor profiles showed that the spices at their optimum levels were easily detectable by the panel. The response of the panelists varied depending upon the person. Some panelists found the level of spice too high for certain samples, whereas others found it acceptable. Samples containing chilli powder or black pepper had a mildly hot flavor. Ground beef containing star anise or fennel had a moderate to distinct licorice flavor. Samples with cinnamon, cloves, or nutmeg were also easily identified (Table 4).

Microbiology - There was no difference in aerobic plate counts between control and cooked ground beef samples containing the retail and USU spice blends (Fig. 3). Thus, spices did not have antimicrobial effects in a cooked, refrigerated ground beef system.

Conclusion

In conclusion, all spices imparted a distinctive flavor to the cooked ground beef and had marked antioxidant properties. These traditional spices do not simply mask the rancid off-flavors but also have antioxidant effects. These spices could provide an alternative to synthetic antioxidants such as butylated hydroxytoluene (BHT) or butylated hydroxyanisole (BHA).

References

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Table 1. Mean thiobarbituric acid (TBA) values for all 13 spices of Garam Masala. Means were pooled for stor -age time after cooking (1, 8 and 15 days) and 3 replicates.

TREATMENT / LEVEL (% meat wt)	TBA (ppm MDA)
CONTROL (0.0)	3.41
CARAWAY (0.1)	2.40
CARAWAY (0.5)	2.66
CARAWAY (1.0)	1.26
CHILI (0.1)	2.33
CHILI (0.5)	1.13
CHILI (1.0)	1.08
CLOVES (0.1)	0.76
CLOVES (0.5)	0.96
CLOVES (1.0)	0.88
CARDAM (0.1)	2.69
CARDAM (0.5)	2.22
CARDAM (1.0)	1.11
NUTMEG (0.1)	2.16
NUTMEG (0.5)	0.97
NUTMEG (1.0)	1.04
PEPPER (0.1)	2.87
PEPPER (0.5)	1.28
PEPPER (1.0)	1.26
CORIAND (0.1)	2.39
CORIAND (0.5)	1.61
CORIAND (1.0)	1.03
CUMIN (0.1)	2.76
CUMIN (0.5)	1.08
CUMIN (1.0)	1.04
SALT (0.1)	2.89
SALT (0.5)	1.92
SALT (1.0)	2.27
STAR ANI (0.1)	2.55
STAR ANI (0.5)	0.97
STAR ANI (1.0)	0.71
FENNEL (0.1)	2.32
FENNEL (0.5)	1.39
FENNEL (1.0)	0.99
CINNAM (0.1)	1.66
CINNAM (0.5)	0.76
CINNAM (1.0)	0.78
GINGER (0.1)	2.51
GINGER (0.5)	0.88
GINGER (1.0)	1.33
$LSD_{0.05}$	0.69

Table 2. Mean thiobarbituric acid (TBA) values for all 5 spices of chinese 5-spice. Means were pooled for storage time after cooking (1, 8 and 15 days) and 3 replicates.

TREATMENT	LEVEL (% meat wt)	TBA (ppm MDA)
CONTROL	0.0	3.41
STAR ANISE	0.1	2.55
STAR ANISE	0.5	0.97
STAR ANISE	1.0	0.71
FENNEL	0.1	2.32
FENNEL	0.5	1.39
FENNEL	1.0	0.99
CLOVES	0.1	0.76
CLOVES	0.5	0.97
CLOVES	1.0	0.88
PEPPER	0.1	2.87
PEPPER	0.5	1.28
PEPPER	1.0	1.26
CINNAMON	0.1	1.66
CINNAMON	0.5	0.76
CINNAMON	1.0	0.78
$LSD_{0.05}$		0.76

Table 3. TBA values (treatment means pooled over storage time) for retail and USU Garam Masala (GM) and Chinese 5-Spice. Means with the same letter are not different.

A. Comparison of Retail Spices at 0.1, 0.5 and 1.0% of Meat Weight.

TREATMENT	LEVEL (% meat wt)	TBA (ppm MDA)
CONTROL	0.0	3.48 a
RETAIL GM	0.1	1.73 b
RETAIL GM	0.5	1.29 bc
RETAIL GM	1.0	0.82 c
RETAIL 5-SPICE	0.1	0.99 c
RETAIL 5-SPICE	0.5	0.73 c
RETAIL 5-SPICE	1.0	1.00 c
$LSD_{0.05}$		0.57

B. Comparison of USU and Retail Spice Blends.

TREATMENT	LEVEL (% meat wt)	TBA (ppm MDA)
CONTROL	0.0	3.26 a
USU GM	1.0	0.73 b
USU 5-SPICE	0.5	0.78 b
RETAIL GM	1.0	0.79 b
RETAIL 5-SPICE	0.5	0.73 b
$LSD_{0.05}$		0.46

Fig. 3. Aerobic plate count means for spice blends pooled over storage time (1, 8 or 15 days) and 2 replicates

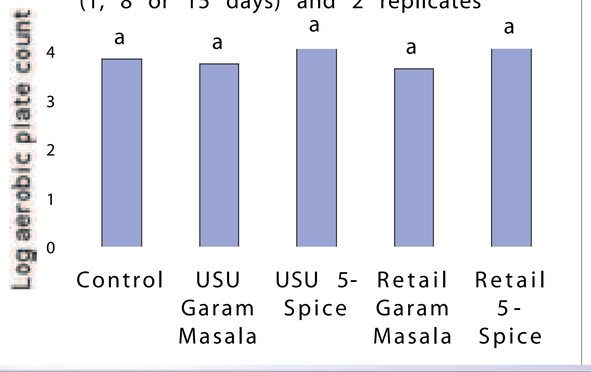


Fig. 1. TBA values for individual spices of Garam Masala at their optimum level. Treatment means were pooled over storage time (1, 8 or 15 days) for 3 replicates. Means with the same letter are not different ($p<0.05$).

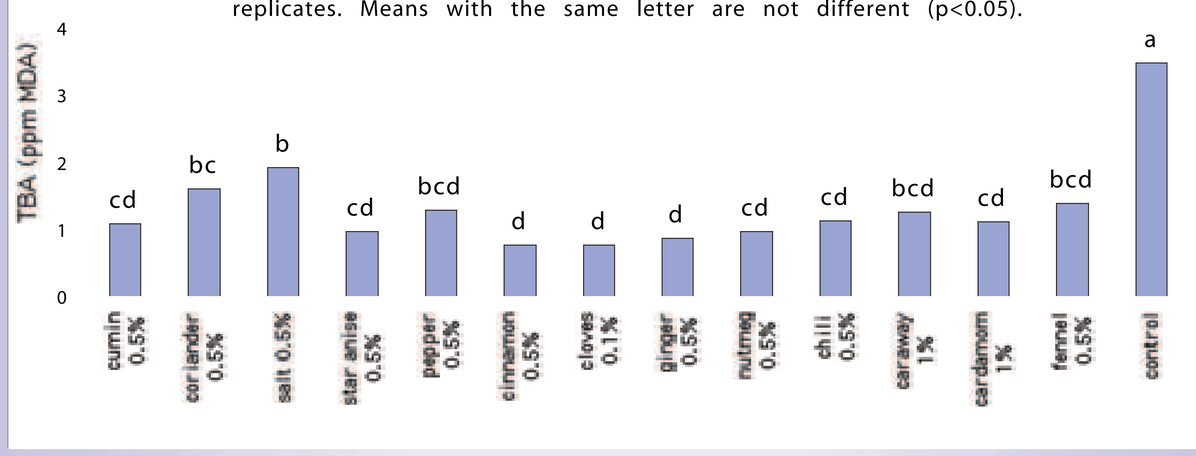


Fig. 2. TBA values for individual spices of Chinese 5 Spice at their optimum level. Treatment means were pooled over storage time (1, 8 or 15 days) for 3 replicates. Means with the same letter are not different ($p<0.05$).

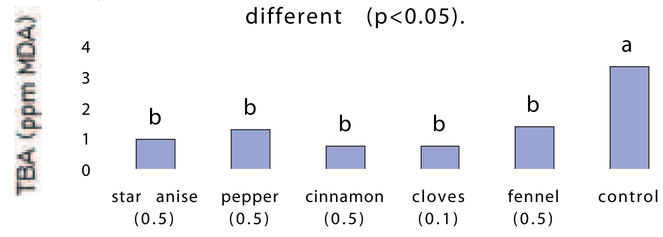


Table 4. Sensory attributes of individual spices and spice blends (at their optimum level)

SPICE	LEVEL (% meat wt)	FLAVOR DETECTABLE ?	FLAVOR DESIRABLE ?	FLAVOR DESCRIPTION
CONTROL	0.0	Yes	Variable	Oily, salty, beefy, good, less intense
CARAWAY	1.0	Ò	depending	Spicy, mild, dill like flavor
CHILI	0.5	Ò	on	Bland, pizza spice like flavor
CLOVES	0.1	Ò	individual	Strong odor like used in dentistÕs office
CARDAMOM	1.0	Ò	panelist	Good, spicy, hot, mexican spice flavor
NUTMEG	0.5	Ò	Ò	Bland, too spicy, like nutmeg
BLACK PEPPER	0.5	Ò	Ò	Very peppery, hot, good, too hot
CORIANDER	0.5	Ò	Ò	Spicy
CUMIN	0.5	Ò	Ò	Spicy, taco style spice, hot, like licorice
SALT	0.5	Ò	Ò	Salty
STAR ANISE	0.5	Ò	Ò	Licorice like flavor, spicy, good
FENNEL	0.5	Ò	Ò	Spicy, licorice flavor, odd, too strong
CINNAMON	0.5	Ò	Ò	Cinnamon like flavor, spicy, ok flavor
GINGER	0.5	Ò	Ò	Weak flavor and weak odor
RETAIL GM	1.0	Ò	Ò	Strong spicy flavor
USU GM	1.0	Ò	Ò	Strong spicy flavor, like chili
RETAIL 5-SPICE	0.5	Ò	Ò	Strong, licorice like flavor, spicy, good
USU 5-SPICE	0.5	Ò	Ò	Spicy, licorice flavor, good