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RESEARCH REPORT

Study shows smoking of cheddar cheese has positive effects

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Executive Summary

The purpose of this project was to determine the effects of smoking on 1) the growth of nonstarter lactic acid bacteria in cheese, and 2) proteolysis and flavor development with the view of developing smoked cheese varieties for Cal Poly Creamery. Blocks of cheddar cheese manufactured at Cal Poly Creamery were taken at one, three, six and nine months of ripening (at 10°C) and subjected to wood smoke generated by heating to 120°F hickory wood chips that had been soaked in water for 30 minutes. After smoking, the block was vacuum-packaged and placed back in the ripening room for further ripening. Composition of the cheese was determined. Samples of the cheese were taken at intervals during ripening for enumeration of nonstarter count and proteolysis. A trained panel performed sensory analyses of six- and nine-month-old cheeses. Results show that application of wood smoke to cheese did not negatively affect the growth of non-starter lactic acid bacteria during ripening. Furthermore, application of smoke did not significantly affect primary and secondary proteolysis during the ripening of cheese. The sensory panel perceived that those cheeses smoked after six months of ripening had the best smoke flavor. The results of the project has led to the introduction of smoked cheddar and smoked Gouda cheeses by the California Polytechnic State University, San Luis Obispo Creamery.

Smoking of cheese performs two functions: it imparts a characteristic smoked flavor and helps preserve cheese.

Materials and Methods

Cheese manufacture: Six 10-kg blocks (A-F) of vacuum-packaged cheddar cheese manufactured at Cal Poly Creamery were taken on three occasions (trials) for this study. Five blocks (A, C, D, E and F) were used for Trial 1. All the cheeses were manufactured by the standard 4.5 h (setting to milling pH of 5.4) method. The cheeses were ripened at 10°C. At various intervals, a cheese block was removed from the ripening room and subjected to wood smoke. After smoking, the block was vacuum-packaged and placed back in the ripening room.

Smoking of Cheeses: The cheeses were smoked in a Joe-Smoker model BIG JOE 140 (PK Manufacturing Inc., KS). The smoke source was hickory wood chips soaked in water for 30 minutes prior to heating at 120°F. When the inside of smoker was filled with smoke, the cheese was placed in the racks of smoker for 20 minutes.

Cheese	Treatment
Block 1 (A)	Control: The cheese was ripened for 9 months without smoking. Samples were taken after 1, 3, 6 and 9 months for microbiological analysis and proteolysis.
Block 2 (B)	The cheese was smoked 1 day post manufacture, and then ripened for 9 months. Samples were taken from Block 2 after 1, 3, 6 and 9 months of ripening for proteolysis and microbiological analysis.
Block 3 (C)	The cheese was smoked after 1 month of ripening, and then ripened for an additional 8 months. Samples were taken from Block 2 after 3, 6 and 9 months of ripening for proteolysis and microbiological analysis.
Block 4 (D)	The cheese was smoked after 3 months of ripening and then ripened for additional 6 months. Samples were taken from Block 3 after 6 and 9 months of ripening for proteolysis and microbiological analysis.
Block 5 (E)	The cheese was smoked after 6 months of ripening and then ripened for an additional 3 months. Samples were taken after 9 months of ripening.
Block 6 (F)	The cheese was smoked after 9 months of ripening. Samples were taken immediately after smoking for analysis.

Table 1. Time protocol for smoking and sampling of smoked cheeses.

Sampling: The experimental design for smoking of cheese and sampling of the smoked cheeses is given in Table 1. Samples for analysis were stored at –20°C until analyzed.

Compositional analysis: Proximate composition of the cheeses as performed after one-month-old post manufacture. Moisture was determined by the CEM microwave oven method, fat by the Babcock method, protein by Kjeldahl N ´ 6.38 and pH.

Microbiological analysis: Non-starter lactic acid bacteria in the cheeses during ripening were enumerated on Rogosa agar.

Proteolysis: Samples were taken periodically from Block 1 after one, three, six and nine months of ripening for proteolysis. Primary proteolysis was determined by urea-PAGE of cheeses and water soluble N. The secondary proteolysis in the cheeses was examined by determining total free amino acids by Cd-ninhydrin method.

Sensory analysis: Cheeses were evaluated for sensory characteristics after six and nine months of ripening by a trained panel.

Results and Discussion

The mean proximate composition of the cheese was within normal values for cheddar. The results show that smoking caused insignificant changes in the moisture content of cheddar cheese during ripening. As expected, the overall pH of cheese increased during ripening and was not affected by smoking (Table 4, opposite).

Smoked cheeses had generally higher numbers of NSLAB during ripening for six months than control cheeses. However, after nine months of ripening the differences in NSLAB counts between smoked and non-smoked cheeses were insignificant.

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A. Block/Treatment	Mean pH of cheese during ripening				
	1d	1 mo	3 mo	6 mo	9 mo
1 (No smoking)	5.17	5.15	5.15	5.37	5.36
2 (smoked after 1 d)			5.17	5.34	5.44
3 (smoked after 1 mo)				5.31	5.44
4 (smoked after 3 mo)				5.39	5.40
5 (smoked after 6 mo)					5.38
6 (smoked after 9 mo)					5.37

Table 4. Effect of smoking of on the pH of Cheddar cheese during ripening

Results show similar water-soluble nitrogen levels, suggesting that smoking of cheese did not affect primary proteolysis. Similarly, urea-PAGE of the cheeses also showed no differences between the smoked and non-smoked after nine months of ripening.

As expected, levels of free amino acids increased during ripening, suggesting that smoking did not influence the activities of starter and nonstarter enzymes that cause the release of free amino acids in cheese.

Results of sensory analysis of the cheeses are given in Tables 8 and 9. A6 is six-month-old control cheddar cheese while B6, C6, D6 and E6 are six-month-old cheddar cheeses which were smoked after one day, one, three, and six months respectively. Panelists awarded highest smoked flavor to D6 and E6, i.e., cheeses that were smoked after three and six months of ripening, respectively. A9 is nine-month-old control cheddar cheese while B9, C9, D9 and E9 are six-month-old cheddar cheeses which were smoked after one, three, six and nine months respectively. Panelists awarded the highest smoke flavor to nine-month-old cheeses that were smoked after six months of ripening. Cheeses that were not smoked had higher milkfat flavor, diacetyl, cooked and whey notes than smoked cheeses.

Table 8. Sensory profiles of control and smoked Cheddar cheese after six months of ripening as found by a trained 14-member panel.

Attribute	A6	B6	C6	D6	E6
Cooked	3.3a	2.4b	2.2b	1.8bc	1.9c
Whey	3.2a	1.1b	1.3b	0.8bc	0.5c
Diacetyl	1.5a	0b	0b	0b	0b
Milkfat	3.4a	0b	0b	0b	0b
Fruity	0	0	0	0	0
Sulfur	1.5b	1.5b	1.4b	2.1a	1.5b
FFA	0	0	0	0	0
Brothy	2.5b	2.5b	2.1b	3.2a	3.3a
Nutty	1a	0b	0b	0b	0b
Salty	2.0a	2.0a	2.0a	2.0a	2.0a
Sweet	1.5a	1.1a	1.0ab	0.6b	0.4b
Bitter	0	0	0	0	0
Sour	3.5a	3.2a	3.3a	3.4a	3.4a
Smokey	0d	3b	1.9c	4.4a	4.6a
Skunkey	0c	0c	0c	2.4a	1.3b

Table 9. Sensory profiles of control and smoked Cheddar cheese after nine months of ripening as found by a trained 14-member panel.

Attribute	A9	B9	C9	D9	E9
Cooked	3.6a	1.2b	1.3b	1.2b	1.5b
Whey	3.5a	1.0c	1.9b	1.3c	1.5bc
Diacetyl	0	0	0	0	0
Milkfat	3.2a	1.4b	1.2b	1.4b	1.6b
Fruity	0	0	0	0	0
Sulfur	2.9a	1.1b	1.3b	1.0b	1.6b
FFA	0	0	0	0	0
Brothy	2.1b	2.2b	3.1a	2.1b	3.1a
Nutty	1.5a	0b	0b	0b	0b
Salty	1.8a	1.6ab	1.7a	2.0a	1.5b
Sweet	1.6a	1.0b	1.0b	0.9b	1.9b
Bitter	1.1b	0c	0.6c	1.2b	2.1a
Sour	3.5a	3.2a	3.5a	3.2a	3.5a
Smokey	0d	3.4b	1.8c	4.4a	3.2b
Skunkey	0c	0c	0c	2.3a	1.1b

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Conclusions

It can be concluded from the study that smoking did not negatively affect the growth of non-starter lactic acid bacteria during ripening of Cheddar cheeses. Smoking did not significantly affect primary and secondary proteolysis during the ripening of Cheddar cheese. The sensory panel perceived that those cheeses smoked after six months of ripening had the best smoke flavor.

Major Accomplishments

- Knowledge of the process of application of natural smoke to cheese.
- Knowledge of the effect of smoking on growth of nonstarter lactic acid bacteria, proteolysis and flavor development of cheese.
- Results of the study have resulted in the addition of two varieties of smoked cheeses to the line of cheeses being marketed by Cal Poly Creamery. The two new varieties are smoked Cheddar and smoked Gouda.

Impact Statements

The main impact of the project is the current production and marketing of smoked cheddar and Gouda cheeses by Cal Poly Creamery

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For More Information

This research report contains summarized results of Nana Farkye's study entitled "Development of a Line of Smoked Cheeses for Cal Poly Creamery," ARI Project No. 01-3-004 (Research Focus Area: *Food Science*). To view and/or obtain a copy of the complete final report, or to obtain additional information about this or other research projects, visit the ARI website at *ari.calstate.edu*. For information on projects specific to Cal Poly San Luis Obispo, visit the Cal Poly ARI website at *ari.calpoly.edu*.

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