

Texture Profiles of Frozen Cheese Pizzas and Effects of Heating in Microwave or Conventional Oven

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냉동 치즈피자의 텍스처 프로파일과 가열방법에 따른 영향

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Abstract

A texture profile for frozen pizzas was developed and applied to a comparison of the texture of frozen pizzas heated by conventional and microwave ovens. The texture profile consisted of 29 attributes evaluated at the following five stages: visual and manual, lip feel, first bite, mastication, and swallowing. The microwave pizza tended to be more crisp, dry, and rough but less tender than the conventionally heated pizza. Separate evaluations of the center and edge portions showed differences only in top greasiness, wetness of sauce on palate, moisture release for both types of pizza suggesting that the separated evaluations were not necessarily required. The edge tended to be less greasy and moist than the center possibly because it is more susceptible to overcooking and subsequent drying out.

요약

이 연구에서는 냉동피자에 대한 텍스처 프로필을 수행하여 전통적인 오븐과 microwave 오븐으로 가열한 피자 텍스처 품질을 비교하였다. 개발된 텍스처 특성은 29가지였으며, 눈과 손으로 평가하는 단계, 입술에 대한 촉감, 한번 씹는 단계, 저작 단계, 그리고 삼키는 단계의 다섯 단계로 평가되었다. microwave로 가열된 피자가 전통적인 오븐으로 가열한 피자보다 더 바삭바삭하고 덜 부드럽다고 평가되었다. 피자를 가장자리와 중심부위로 나누어 평가시 top greasiness, wetness of sauce on palate, moisture release의 특성에서만 큰 차이를 나타내어 피자의 텍스처 평가시 꼭 두 부위를 나누어 평가할 필요는 없었다고 할 수 있다. 피자의 가장자리는 가운데 부분보다 덜 기름지고 덜 촉촉하다고 평가되었는데 microwave 오븐으로 가열된 피자의 경우 단시간내에 고열을 받으며 가장자리가 더 빨리 익혀지기 쉬우므로 결과적으로 더 건조해졌기 때문이라고 생각된다.

I. Introduction

Texture profile analysis(TPA) is originally developed method to examine the textural parameters of foods into three major categories: mechanical, geometrical, and a less rigorously defined group of miscellaneous textural properties¹⁾. Although the TPA has been applied to the sensory evaluation of various food product²⁻⁷⁾ in years, no reports were available in the literature on texture profiling of a complex food system, like pizza, with multiple ingredients and components. The objectives of this study were to develop a texture profile for frozen pizza and to use profile for comparing frozen pizzas prepared by the same manufacturer heated by conventional and microwave ovens.

II. Materials and Methods

1. Panelist Information

The panelists consisted of five graduate students who majored in Food Science. All panelists had received prior experiences in descriptive methods of sensory analysis through their courseworks. Specific training for texture profiling before initiating the pizza study included the followings:

Reading assignments on articles related to sensory TPA. Formal lectures on the basic principles of sensory TPA. Practice with scales and references for hardness, fracturability, viscosity, adhesiveness, and chewiness.

Exposures to selected geometrical properties. Development of evaluation procedures and terminology for

several types of brownies, whipped toppings and gelatin. Application of quantitative descriptive analysis to the textural attributes of cooked rice.

2. Sample Handling

Forzen cheese pizzas used in this study were purchased at a local supermarket and then stored in the

Table 1. Texture profiling technique and definitions of terms for pizzas

Terms	Procedure/Definitions
STAGE I:	VISUAL AND MANUAL EVALUATION
Uniformity of cheese	I. Visually evaluate surface for:
Uniformity of sauce	
Outer edge dryness	
Degree of warping	II. Pick up pizza slice using thumb and index finger on outside edges and balance with remaining fingers. Evaluate for:
Crust thickness	Degree that slice bends from horizontal
Fineness of grain	1/16 in. ~3/4 in.
Uniformity of grain	Size of air cells
Greasy finger feel	Even spacing of air cells
Moist finger feel	Degree that sample feels greasy on fingers
Roughness of crust	Degree that sample feels moist on fingers
STAGE II.	Degree that sample feels rough to fingers
	LIP FEEL EVALUATION
Greasiness of surface	Cut 1 inch from the outer edge and evaluate inner pience first. Place the sample between the lips and evaluate for:
Greasiness of crust	Degree that top greasiness is perceived on lips
Bottom roughness	Degree greasiness is perceived on lips
Dryness of crust	Degree of perceived roughness on lips
STAGE III	Degree dryness is perceived on lips
	FIRST BITE
Uniformity of bite	Cut 1 inch from the outer edge and evaluate inner pience first.
Tenderness	Place approximately 1 inch of the sample in mouth: bite
Crispness	down with front teeth applying a steady force and evaluate for:
Wetness of sauce	Degree to which sample is the same from the outside to the center
Pullaway	Force required to bite through sample
STAGE IV	Crunchy sound perceived as bite through sample
	Amount of moisture perceived on palate when bite through sample
Moisture release	Force required to pull sample away from mouth after first bite
Adhesiveness of cheese to crust	MASTICATION
Adhesiveness to palate	Masticate sample with molars to point of swallowing and evaluate for:
	Amount of moisture released from sample at end of the third chew
Adhesiveness to teeth	Degree to which cheese separates from crust during
	first three chews
Chewiness	Force required to remove sample from palate
	durig chewing
	Force required to remove sample from and teeth
	around teeth during chewing
	Total perceived force required to reduce sample
	to a consistency ready for swallowing when chewed
	at a constant rate of force application
	Time required for sample to breakdown to a consistency
	for swallowing
	Degree to which the mass holds together during mastication
	of product
	STAGE V
	SWALLOWING
	After mastication and breakdown swallow sample
	and evaluate for:
	Perceived degree of grease left on teeth and palate after swallowing
	Amount of saliva produced to cleanse mouth after swallowing
	Amount of material left in and around molar teeth

freezer until the time of evaluation. All products for trainings and tests were prepared according to the directions on the package. All heated and cut pizzas were prepared freshly for each evaluation and kept warm until serving time by placing on a warming tray on the high temperature setting. Individual pizza slices were served to panelists on plain white paper plates. In addition, Panelists were provided with a sharp knife

for trimming off the outer edge of the pizza, distilled and deionized water at room temperature, and cups for expectoration.

References were available, if desired, for refreshing memories during data collection. All food products used as references were also purchased from the local supermarket. The reference for the high end of the top greasiness scale in Stage II was prepared by blen-

TEXTURE PROFILING - PIZZAS										
DATE _____			NAME _____							
STAGE I										
A. Visual										
			Uniformity of cheese on surface							
1	2	3	4	5	6	7	8	9	10	
uneven										even
			Uniformity of sauce on surface							
1	2	3	4	5	6	7	8	9	10	
uneven										even
			Outer edge dryness							
1	2	3	4	5	6	7	8	9	10	
not dry										very dry
B. manual										
			Degree of warping							
1	2	3	4	5	6	7	8	9	10	
no angle										90° angle
			Crust thickness							
1	2	3	4	5	6	7	8	9	10	
1/16 in.										3/4 in.
			Fineness of grain							
1	2	3	4	5	6	7	8	9	10	
cut waffle										pound cake
			Uniformity of grain							
1	2	3	4	5	6	7	8	9	10	
over mixed muffin										pound cake
			Greasy finger feeling							
1	2	3	4	5	6	7	8	9	10	
cracker										pie crust
			Moist finger feeling							
1	2	3	4	5	6	7	8	9	10	
cracker										biscuit dough
			Roughness of crust							
1	2	3	4	5	6	7	8	9	10	
pie crust										melba toast
STAGE II										
Evaluate and mark center piece first.										
			Greasiness of top							
1	2	3	4	5	6	7	8	9	10	
tomato sauce										tomato sauce with oil
			Greasiness of bottom							
1	2	3	4	5	6	7	8	9	10	
melba toast										pie crust
			Bottom roughness							
1	2	3	4	5	6	7	8	9	10	
pie crust										melba toast
			Crust dryness							
1	2	3	4	5	6	7	8	9	10	
biscuit dough										saline cracker

Fig. 1. Score sheet for texture profiling of frozen pizza with references.

ding 1 tbsp. of soybean oil with 1/4C. of tomato sauce. As a high reference in Stages III and IV, tomato sauce bread was prepared by covering the surface of white bread uniformly with 2 tbsp. of tomato sauce and folding in half.

3. Sensory Evaluation Procedures

The complete texture profile of frozen pizzas from conceptualization to data summarization was conducted in sixteen 2-hour sessions. The study was divided into four parts: orientation (session 1), training (session 2~

STAGE III										
Evaluate and mark center piece first.										
Uniformity of bite										
1	2	3	4	5	6	7	8	9	10	
french bread										sugar cookie
Tenderness										
1	2	3	4	5	6	7	8	9	10	
vanilla wafer										sugar cookie
Crispsness										
1	2	3	4	5	6	7	8	9	10	
white bread										saltine cracker
Pullawy										
1	2	3	4	5	6	7	8	9	10	
sugar cookie										biscuit dough
Wetness of sauce on palate										
1	2	3	4	5	6	7	8	9	10	
white bread										tomato sauce bread
STAGE IV										
Evaluate and mark center piece first.										
Moisture release										
1	2	3	4	5	6	7	8	9	10	
white bread										tomato sauce bread
Adhesiveness of cheese to crust										
1	2	3	4	5	6	7	8	9	10	
cold cheese on bread										melted cheese on bread
Adhesiveness to palate										
1	2	3	4	5	6	7	8	9	10	
saltine cracker										peanut butter sandwich
Adhesiveness to tooth										
1	2	3	4	5	6	7	8	9	10	
saltine cracker										peanut butter sandwich
Cohesiveness of mass										
1	2	3	4	5	6	7	8	9	10	
pie crust										brownie
Chewiness										
1	2	3	4	5	6	7	8	9	10	
sugar cookie										biscuit dough
Rate of breakdown										
1	2	3	4	5	6	7	8	9	10	
biscuit dough										sugar cookie
STAGE V										
Evaluate and mark center piece first.										
Mouth-coating										
1	2	3	4	5	6	7	8	9	10	
saltine cracker										pie crust
Saliva inducing										
1	2	3	4	5	6	7	8	9	10	
pie crust										brownie
Tooth packing										
1	2	3	4	5	6	7	8	9	10	
biscuit dough										melba toast

Fig. 1. Continued.

13), evaluation of test products (session 14~15), and data analysis and discussion of findings (session 16).

Definitions for textural attributes and descriptions of evaluation procedures used for data collection are provided in Table 1. Attributes related to visual appearance and manual perceptions were also included in the profile since they contributed to the overall impression of the textural quality of the products and influenced later oral perceptions of texture. The score sheet which the texture profile panel used for its actual evaluations of the test products with references used to anchor the extreme ends of the intensity scale is given in Fig. 1. The 10-point category scale was anchored at either end with a reference to represent the extremes of the textural characteristics possible in the test products. Panelists individually evaluated both test samples in a session followed by a group discussion to reach a consensus opinion for each attributes. In session 14, the panel first assessed the conventionally heated pizzas and then the microwave-heated pizzas. In session 15, the order of presentation was reversed. Data were analyzed with mean values of the two consensus scorings.

III. Results and Discussion

Results from the texture profiles for frozen pizzas prepared by heating in conventional and microwave ovens are summarized in table 2. Mean scores for the most important differences in textural parameters between the two types of frozen pizzas are reported in table 3 and 4. Since no statistical analyses were conducted on the data, the following method was arbitrarily used to determine the difference(d) between the consensus treatment mean scores for a given attribute: $d \geq 3$ unit = major difference, $2 \text{ units} < d \leq 3 \text{ units}$ = minor differences. Most differences were observed for attributes assessed in Stages I-III.

The pizzas heated in the microwave oven exhibited more crispness and less warping, uniformity of bite, and tenderness than the pizzas heated in the conventional oven. It seems logical to show the positive association between warping and tenderness as well as their negative association with crispness. A firm product would be less tender and crisper and probably would tend to warp to a lesser extent than a soft product. Uniformity of bite showed difference between the two types of pizzas because of the extreme difference in firmness between the crisp crust and soft toppings of the microwave toppings, in contrast, the crust

Table 2. Texture profiling scores* of frozen pizzas heated by microwave and conventional oven

ATTRIBUTES	MICROWAVE		CONVENTIONAL	
	CENTER	EDGE	CENTER	EDGE
STAGE I				
Uniformity of cheese	6.0		6.5	
Uniformity of sauce	8.0		8.5	
Edge dryness		6.5		7.5
Warping	1.0		6.5	
Crust thickness	7.0		5.5	
Fineness of grain	3.5		3.5	
Uniformity of grain	2.0		4.0	
Greasy finger feeling	8.5		8.5	
Moist finger feeling	3.0		5.5	
Roughness of crust	6.0		4.0	
STAGE II				
Greasiness of top	6.5	4.0	8.0	5.0
Greasiness of bottom	7.5	6.0	6.0	7.0
Bottom Roughness	4.0	5.5	2.5	3.5
Crust dryness	8.5	9.0	7.0	7.0
STAGE III				
Uniformity of bite	3.5	3.0	9.0	5.0
Tenderness	3.5	2.5	8.5	6.0
Crispness	8.0	9.0	3.5	6.0
Pullaway	6.0	2.5	6.0	4.5
Wetness of sauce	6.5	4.0	8.5	5.5
STAGE IV				
Moisture release	7.0	4.0	8.5	5.5
Adhesiveness to palate	5.5	7.0	4.0	6.5
Adhesiveness to teeth	7.0	6.5	7.0	7.0
Cohesiveness of mass to teeth	4.5	4.5	6.0	6.0
Chewiness	6.5	4.5	7.0	6.0
Rate of breakdown	4.5	5.5	6.0	6.5
STAGE V				
Mouth-coating	8.0	6.5	6.5	7.0
Saliva inducing	8.0	7.0	8.5	7.5
Tooth packing	7.5	7.5	5.0	7.0

*Consensus scores: average of two scoring sessions, lowest intensity of attribute=1.0; highest intensity of attribute=10.0.

of the conventionally baked pizza was quite similar in softness to the topping.

Low scores for uniformity of grain, moist finger feeling, edge pullaway, and center wetness of sauce on palate and high scores for crust roughness, edge crust dryness and center tooth packing were obtained for microwave-heated pizza relative to the conventionally heated pizza. Low ratings for moist finger feeling and high crust roughness and crust dryness appear to be related to the low degree of warping and tenderness and high degree of crispness associated with the microwave pizzas. Perhaps the pizzas were cooked to two different degrees of doneness. Because microwaving accelerates the heating process for food⁸⁾, it would have

Table 3. Major differences* in textural attributes of frozen pizzas heated by microwave or conventional oven

Attributes	Microwave		Conventional	
	Center	Edge	Center	Edge
Wrapping	1.0		6.5	
Uniformity of bite	3.5		9.0	
Tenderness	3.5	2.5	8.5	6.0
Crispness	8.0	9.0	3.5	6.0

* $d \geq 3$. Based on average of 2 consensus scores from different test sessions. Lowest intensity of attribute=1.0; highest intensity of attribute=10.0.

Table 4. Minor differences* in textural attributes of frozen pizzas heated by microwave or conventional oven

Attributes	Microwave		Conventional	
	Center	Edge	Center	Edge
Uniformity of grain	2.0		4.0	
Moist finger feelings	3.0		5.5	
Roughness of crust	6.0		4.0	
Bottom roughness		5.5		3.5
Bottom crust dryness		9.0		7.0
Uniformity of bite		3.0		5.0
Pullaway		2.5		4.5
Wetness of sauce	6.5		8.5	
Tooth packing	7.5		5.0	

* $2 < d \leq 3$. Based on average of 2 consensus scores from different test sessions. Lowest intensity of attribute=1.0; highest intensity of attribute=10.0.

been easy to overcook the microwave pizzas and produce above effects.

The differences observed for uniformity of grain are probably related to differences in product formulation and commercial processing operations. Modifications of dough formulation: for example, the addition of ex-

tra fat, are often necessary in order to produce acceptable baked goods in the microwave.

Separate evaluations of the center and edge portions showed only three differences bigger than the score 2 in top greasiness, wetness of asuce on palate, moisture release for both types of pizza. Considering the profiled 29 textural parameters, separate evaluations of the center and edge portions may not have been necessary. In comparison to the center, the edge tended to be less greasy and moist possibly because it is more susceptible to overcooking and subsequent drying out.

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