

# SENSORY QUALITY OF MOLECULAR DISHES AND CONSUMERS' ATTITUDES TOWARDS THEM

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## ABSTRACT

The aim of the study was to explore consumers' attitude toward molecular cuisine, specifically the sensory evaluation of these dishes. The experiment was performed in a laboratory among 10 panelists and 150 consumers to compare a sensory profile of molecular courses to their traditional versions.

Sensory profile of traditional dishes had a significantly higher, or comparable intensity in sensory attributes than molecular version and was preferred by consumers ( $p \leq 0.05$ ). The results indicate positive attitude of consumers to modernist dishes and their moderately high sensory-experience ratings. Most of them showed willingness to try other molecular dishes in the future.

*Keywords:* molecular cuisine, sensory quality, consumer preference, food attitude, innovative technique

## 1. INTRODUCTION

The progress of civilization, globalization, increasing pace of life, economic and socio-demographic changes have all affected overall consumption pattern of food over the years. Modern consumers look for new experiences and there are fewer new products and services to surprise them.

Catering establishments want to meet consumers' expectations, so they try to expand and adjust their offer by adding new dishes to the menu card. Modernist cuisine also called molecular is an example of such activities. It is a new way of cooking, defined as 'producing food, using new tools, ingredients and methods', which has not been used in the food service so far (THIS, 2013 a, b). Among many of its features are obtaining surprising textures and forms as well as an enhanced ability to add to the original flavor and odor. Molecular cuisine uses both food additives (emulsifiers, stabilizers, thickeners and gelling agents) and new techniques (spherification, gelification, emulsification, foaming, blast freezing, sous-vide, lyophilization, concentration, homogenization, dehydration, and deconstruction) (IVANOVIC *et al.*, 2011; LEE and ROGERS, 2012; VEGA and CASTELLS, 2012). The dishes are served as a tasting menu in the form of dozen small portions, typically on a variety of plates and unusual tableware (IVANOVIC *et al.*, 2011). Chefs work to provide an interesting multisensory sensation to arouse emotions and stimulate senses beyond taste to make the consumption of the dishes a unique experience (YEK and STRUWE, 2008).

The preferences and/or food aversions of each individual is always 'colored' with emotions (DEN UIJL *et al.*, 2014). Food choices are often associated with emotional states (VAN TRIJP and VAN KLEEF, 2008), expressed in dichotomies: pleasure/displeasure, ingestion/rejection, acceptance/rejection. Accordingly, the food preferences of modern consumers, especially toward food offered at catering establishments, are contradictory. On the one hand, perceptions of new food technologies can be affected by the degree of naturalness in food production (SIEGRIST, 2008). On the other hand, customers go to the restaurants not only to satisfy their nutritional requirements, but also to socialize and try new flavors that are not prepared at their homes (TÜZÜNKAN and ALBAYRAK, 2015).

Consumers are paying more attention to the quality of food products and the health benefits associated with their consumption (BARRENA and SÁNCHEZ, 2013). However they may be reluctant to compromise hedonic pleasure for health benefits (VERBEKE, 2006). New food technologies market success depends on consumers' behavioral responses. As a consequence, negative and suspicious attitude towards food technologies may lead to product failure (CHEN *et al.*, 2013).

Only a few studies (YEOMANS *et al.*, 2008; MIELBY and FROST, 2010; GUINÉ *et al.*, 2012; TRAYNOR *et al.*, 2013; FRAAT and ZAINAL, 2016) were dedicated to assess acceptance of molecular dishes and consumers' attitudes. Moreover, any comparison of traditional and molecular cuisine has not been performed so far. For this reason, in this study we:

- explore the knowledge and attitudes toward molecular cuisine and sensory-affective response amongst consumers in a laboratory settings;
- compare the sensory profile of molecular courses and similar traditional dishes to find factors that affect sensory ratings.

## 2. MATERIAL AND METHODS

### 2.1. Data collection and methods

#### 2.1.1 Experimental design

The experiment was carried out in a laboratory environment and consisted of consumer tests and descriptive sensory profiling, hence involved both sensory panel and consumers of the academic subpopulation. The assessed dishes were three courses produced using various techniques applied in molecular cuisine (spherification, gelification and foaming) which were compared with three traditional dishes prepared basing on the same main ingredients (Table 1; Figs. 1-3). We decided to use simply dishes to allow comparison of sensory profiles and limit the results to a single technique used in molecular cuisine.

**Table 1.** Evaluated dishes.

Dishes	Molecular or traditional techniques	Characteristics of the product's appearance	Ingredients
Sample A - Liquid pea ravioli	spherification*	green semi-fluid core closed in an edible spherical coating	green peas, broth, sodium alginate, calcium chloride, seasonings
Sample A-1 - Cream of green pea soup	traditional dish	green creamy soup	green peas, broth, onion, butter, wheat flour, sour cream, seasonings
Sample B - Tomato soup spaghetti	gelification**	orange spaghetti shaped gel	tomatoes, the tomato puree, broth, leek, carrot, agar agar, carob gum, seasonings
Sample B-1 - Pure tomato soup	traditional dish	orange creamy soup	tomatoes, the tomato puree, broth, onion, butter, seasonings
Sample C - Spinach foam	foaming***	green, light like whipped cream foam	spinach, broth, onion, sour cream, butter, xanthan gum, seasonings
Sample C-1 - Spinach dip	traditional dish	thick dark green dip	spinach, onion, natural yoghurt 2% of fat, feta cheese, seasonings

\*Spherification is a technique of creating liquid filled spheres based on the controlled gelling reaction between calcium chloride and sodium alginate (e.g. caviar, gnocchi and ravioli).

\*\*Gelification is a process of turning a liquid into a gel using gelatin, agar agar, carrageenan Kappa and Iota, gellan, xanthan (e.g. spaghetti, pearls or flexible wraps).

\*\*\*Foaming is a process of transforming liquids into light foams using culinary siphon and food additives like xanthan gum, carob gum, agar agar, gelatin etc. to stabilize a foam (IVANOVIC *et al.*, 2011, LEE and ROGERS, 2012).



**Figure 1.** Proposition of the pea dishes plating: A. liquid pea ravioli, A-1 cream of green pea soup.



**Figure 2.** Proposition of the tomato dishes plating: B. tomato soup spaghetti, B-1 pure tomato soup.



**Figure 3.** Proposition of the spinach dishes plating: C. spinach foam, C-1 spinach dip.

### 2.1.2 Sample presentation for evaluation

Samples of dishes (30-40g) were placed in plastic, transparent containers, then covered with a lid, coded and delivered for assessment.

Samples were served at a temperature, at which they are normally consumed. Temperature of cream of green pea soup and pure tomato soup was approximately  $63 \pm 2^{\circ}\text{C}$ . Due to the low stability of gelling agents in higher temperature, molecular spaghetti and ravioli, as well as spinach dip and foam were evaluated at temperature of  $23 \pm 1^{\circ}\text{C}$ . Differentiation of evaluated samples due to the serving temperature was resulted from specific of dish. Evaluation of samples brought to the same temperature would exhibit a disproportionate sensory intensities and does not reflect actual characteristics of dishes.

### 2.1.3 Descriptive sensory profiling

Descriptive sensory profiling of dishes using a quantitative descriptive analysis was evaluated triple by a 10 persons assessing panel, which held expert qualifications (PN-EN ISO 8586:2014-03). Conditions of the assessment were determined in accordance with CIVILLE and CARR (2015). Selection of quality descriptors was carried out in accordance with the procedure of PN-ISO 13299:2003 and presented in Table 4.

### 2.1.4 Consumer testing

Consumer testing consisted of a validated questionnaire survey as well as degree of liking and preference assessment. The questionnaire was validated among 5 people in a pilot study. All problems have been identified. The questionnaire included 8 questions about previous experiences with molecular dishes and their occurrence places (e.g. food service outlets, culinary school), familiarity and understanding of the term 'molecular cuisine', willingness to taste molecular dish in the future as well as consumers gender and age. They were also tasked to indicate their own attitudes towards novel food (novelties enthusiast, traditional consumer who didn't exclude new products, consumer afraid of novelty). Then they received food samples and made sensory assessment. All respondents agreed to participate in research.

An unstructured linear graphical scale, with word anchors (like-dislike) on the edges was used to determine the level of sensory-liking of odor, color, flavor, consistency and overall liking (PN-ISO 4121:1998). The assessors also pointed out the sensory characteristics of the food that influenced their assessment and indicated the feelings accompanying them in relation to the evaluated dishes (liking, surprising, arousing curiosity, innovative, traditional, the challenge for the senses, being skeptical). To determine which version (molecular/traditional) consumers have preferred the most, the paired comparison test (PN-EN ISO 5495:2007) was used. Samples were encoded and served in a pairs (molecular dish vs. traditional).

Consumer tests of dishes were carried out in a group of 150 students and academics of Faculty of Human Nutrition and Consumer Sciences, WULS (SGGW), designed as a study with a convenience sampling. The group was dominated by women (82%) and mainly under 25 years old (86%) (Table 2). The respondents were diverse in their attitude towards food. Among them were novelties enthusiasts (60%), traditional consumers who didn't exclude new products (35.3%), consumers afraid of novelty (low willingness to try new foods) (4.7%).

**Table 2.** Characteristic of consumers surveyed (n=150).

Characteristic of consumers	Respondents' answers	
	Number	Percent (%)
<b>Gender</b>		
Woman	123	82.0
Man	27	18.0
<b>Age</b>		
<25	129	86.0
25-60	21	14.0
<b>Familiarity with the molecular cuisine term</b>		
Yes	120	80.0
No	30	20.0
<b>Understanding the term of molecular cuisine*</b>		
Cuisine based on science (physico - chemical transformations of food)	85	73.9
Experimental cuisine (using scientific experiments)	67	58.3
Cuisine with new, innovative dishes	55	47.8
Cuisine, wherein dishes are presented in another manner than traditionally	80	69.6
Do not know	2	1.7
I understand it in a different way...	0	0.0
<b>Possibility of earlier tasting of molecular cuisine</b>		
Yes	42	28.0
Therein*		
Cooking workshops	13	31.0**
Catering establishment in Poland	9	21.4**
Catering establishment abroad	8	19.1**
Catering school	9	21.4**
At friends' house	7	16.7**
I make it by myself	5	11.9**
Other (at University, at work)	7	16.7**
No	108	78.0**
<b>Attitudes towards novel food</b>		
I am novelties enthusiast	90	60.0
I am traditional consumer, but do not exclude new products	53	35.3
I am afraid of food novelties	7	4.7

\*respondents could choose several answers.

\*\*percent of consumers that responded affirmatively in previous questions (n=42).

## 2.2. Data analysis

The statistical analysis of the results was performed using Statistica software version 13.1 PL (StatSoft, Krakow, Poland). The mean of results, standard error, one-way analysis of variance (ANOVA), as well as coefficient of correlation according Pearson and Spearman's rank were calculated. The result was considered to be statistically significant at the level of materiality equal to 0.05 or 0.001.

### 3. RESULTS AND DISCUSSION

#### 3.1. Familiarity with molecular cuisine in group of consumers

Most of consumers (80%) participating in experiment (n=150), were familiar with term of molecular cuisine (Table 2).

Approximately 28% of surveyed consumers had practical experience with molecular dishes, where of these, about one third consumed it at a cooking workshops, and almost every fifth at catering establishment in Poland or culinary school. Quite low percentage of people trying the dishes at gastronomic establishments in Poland might be caused by small amount of those places and limited financial availability. Almost 63% of the interviewed have not tasted molecular cuisine before.

The term of the 'molecular cuisine' was not associated with only one definition. The most respondents indicated that is cuisine based on physio-chemical changes in food (74%) and the cuisine wherein dishes are presented in another manner than traditionally (69%). Many respondents stated, that is experimental cuisine (using scientific experiments) (58%). The least of respondents indicated that these are innovative dishes (48%). Nobody tried to redefine the term again.

#### 3.2. Consumer sensory - affective response

Consumers were tasked with determining the degree of liking of four sensory characteristics and overall liking in each dish. Mean scores for all individual attributes and statistically significant differences are shown in Table 3.

Table 3. Results of consumer sensory evaluation (n=150).

Sample dishes	Degree of liking (scale 1-10 c.u.) - average ( $\pm$ SE)					Paired comparison test
	Odor	Color	Consistency	Flavor	Overall liking	
A – liquid pea ravioli	5.31 $\pm$ 0.26a	6.45 $\pm$ 0.22a	5.11 $\pm$ 0.27a	5.80 $\pm$ 0.23a	5.92 $\pm$ 0.22a	28
A-1 – cream of green pea	6.53 $\pm$ 0.23b	7.04 $\pm$ 0.20b	6.73 $\pm$ 0.23b	7.34 $\pm$ 0.21b	7.12 $\pm$ 0.22b	87*
B – tomato soup spaghetti	6.43 $\pm$ 0.22a	6.93 $\pm$ 0.21a	6.57 $\pm$ 0.25a	5.73 $\pm$ 0.26a	6.17 $\pm$ 0.25a	37
B-1 – pure tomato soup	7.12 $\pm$ 0.18b	7.31 $\pm$ 0.19a	6.89 $\pm$ 0.22a	7.15 $\pm$ 0.22b	7.11 $\pm$ 0.21b	78*
C – spinach foam	6.56 $\pm$ 0.23a	7.27 $\pm$ 0.19a	6.52 $\pm$ 0.26a	5.39 $\pm$ 0.28a	5.88 $\pm$ 0.25a	35
C-1 – spinach dip	7.57 $\pm$ 0.18b	7.14 $\pm$ 0.21a	6.98 $\pm$ 0.21a	6.95 $\pm$ 0.23b	7.13 $\pm$ 0.20b	89*

a, b, values bearing different letters are significantly different;  $p \leq 0.05$  (differences between molecular and traditional dishes); \*samples in pairs differ significantly  $p \leq 0.001$ .

Among the surveyed consumers (n=150), the degree of liking of molecular dishes was moderately high (5.1-7.3 c.u.) (Table 3).

Traditional dishes (A-1, B-1, C-1) were ranked significantly ( $p \leq 0.05$ ) higher in attributes such as: odor, flavor, overall liking and in sample A-1 also in color and consistency, when compared to molecular ones: A, B, C (Table 3). Moreover, the result of the paired comparison test showed that most of consumers preferred traditional courses,  $p < 0.01$  (Table 3). The high intensity of flavor of traditional courses was the most strongly correlated with overall liking from all analyzed characteristics. The highest Pearson's

correlation coefficient between flavor and overall liking for both traditional (0.84-0.92) and molecular (0.87-0.89) dishes has been calculated ( $\alpha=0.05$ ), while lower for consistency ( $<0.7$ ), color, ( $<0.6$ ) and odor ( $<0.5$ ).

Sensory experience associated with a specific food or beverage does not start with the moment of the consumption. It can begin even before the food is seen, for example by hearing about it from friends, relatives or through mass media (FAVALLI *et al.*, 2013). Therefore, the correlation between perception of certain attributes and previous consumption of molecular cuisine with significance level of 0.05 has been observed, but only for liquid pea ravioli. Consumers who tasted molecular cuisine before, ranked color ( $\rho = 0.33$ ), consistency ( $\rho = 0.29$ ) and overall liking ( $\rho = 0.19$ ) of molecular ravioli higher. Dishes which were related to familiar food or had the potential to evoke positive memories were liked the most. The phenomenon can be explained by research results whose, found that acceptance of an unfamiliar food is largely determined by its degree of similarity to familiar food in individual's diet (MIELBY and FROST, 2010).

The literature reported differences between acceptability of novel and familiar foods among consumers who are food neophobes and neophiliacs. Neophobes were less inclined to try novel foods, while neophiliacs had a higher awareness, willingness to try and rated unfamiliar food more favorably KING *et al.* (2008). Consumers participating in experiment were those, who like new products (60%) or the traditional consumers, who do not exclude novelties (35.3%), but 4.7% of them were consumers who are afraid of novelty (low willingness to try new foods).

Consumers indicated the traits of dish, which had effect on their evaluation (not shown in table).

Among consumers, who preferred molecular versions – novelty enthusiasts (e.g. A sample), the highest percentage of them indicated flavor (about 54%) and consistency (about 42%) as a traits affecting on their evaluation, but for those who chose traditional dishes - traditionalists (e.g. B-1 and C-1 sample), the most important was flavor (71-80%) and odor (about 38%). It is proved by results of correlation in the degree of liking assessment.

Traditional and molecular dishes were intentionally differed in consistency using techniques such as spherification, gelification, and foaming, although, for consumers it was less important in perception than flavor. Similarly in FRAAT and ZAINAL's (2016) study, the greatest effect on chef's acceptance of modernist version of Malaysian Asam Pedas (sphere, foam, powder, sous-vide) the degree of overall liking and consistency-liking had. Odor and color was less important in their research. In our study, just a few respondents indicated non-sensory characteristics when explained their choice. This confirms TUORILA (2007) observations, that sensory-liking usually plays a major role in food choice decisions, and flavor had effect on choice of a particular dish. Authors indicated a significant effect of flavor, quality, novelty, expectation, and familiarity (OLABI *et al.*, 2015), as well as appearance and odor (FERNQVIST and EKELUND, 2014) on quality and its positive correlation with the degree of liking.

Lower scores of molecular dishes may result from the fact that consumer response is based not only on sensory perception, but also on stimulation of many other senses, evoking various intellectual (THIS, 2013b) and aesthetic experiences (MICHEL *et al.*, 2015; YOUSSEF *et al.*, 2015). The concept of this cuisine is aimed to create avant-garde, unique dishes that surprise customers. Although the laboratory evaluation is objective, does not fully reflect dining experience. Many authors noticed lower hedonic scores of dishes in laboratory settings when compared to those assessed at the target consumption atmosphere: at the military field (DA GRAAF *et al.*, 2005), at high altitude field conditions (PREMAVALLI *et al.*, 2009) and on the airplane board (HOLTHUYSEN *et al.*, 2017). Similar observation indicated authors (MICHEL *et al.*, 2015; YOUSSEF *et al.*, 2015). According to

them, visual presentation and the manner of plating, affects its liking and appreciation for example by enhancing a diner's rating of the dish flavor.

### 3.3. Sensory profile of dishes

To determine more detailed differences between traditional and molecular dishes, quantitative descriptive analysis by panelist was performed. The results of the sensory profiling show that most attributes of odor (sweet, brothy, creamy, and specific for dishes) were significantly more intensive in traditional (A-1, B-1, C-1) than molecular dishes (A, B, C) (Table 4). The opposite relationship was observed in intensity of color. Traditional dishes based on green pea or tomato (A-1 and B-1) were characterized by lower intensity of color than their molecular versions (A and B). Spinach foam (C) had significantly lower intensity of color because of dish form - foam, so the high aeration.

Molecular dishes were significantly differed in consistency compared with traditional ones. Liquid pea ravioli (A) was evaluated significantly higher in attributes such density and smoothness ( $p=0.0001$ ). Spinach foam (C) distinguished itself with high fluffiness and low density ( $p=0.001$ ). Tomato dishes have been evaluated using different consistency attributes because of wide variations in consistency (Table 4).

**Table 4.** Sensory profiles of evaluated dishes (n=30).

Attributes	Average (0-10 c.u.) Sample		Attributes	Average (0-10 c.u.) Sample		Attributes	Average (0-10 c.u.) Sample	
	A	A-1		B	B-1		C	C-1
green pea o.	8.10a	7.22b	tomato o.	7.31a	7.94b	spinach o.	7.23a	8.00b
sweet o.	2.26a	2.85a	sweet o.	2.57a	3.31b	garlic o.	6.83a	6.28a
brothy o.	2.68a	5.30b	brothy o.	3.32a	4.05b	lemon o.	1.95a	2.04a
creamy o.	1.52a	2.86b	creamy o.	1.64a	2.45b	creamy o.	1.47a	1.93b
other o.	0.46a	0.23a	other o.	0.22a	0.25a	other o.	0.27a	0.16a
green color	5.93a	4.39b	orange color	6.51a	5.85b	green color	6.08a	6.96b
density	7.63a	6.21b	density	-	3.47	density	3.29a	6.99b
			smoothness	-	7.06			
smoothness	7.08a	5.82b	springiness/elasticity	7.72	-	fluffiness	8.69a	4.63b
			fragility	7.55	-			
			ability to fragmentation	7.77	-			
green pea f.	7.82a	7.48a	tomato f.	7.20a	8.16b	spinach f.	7.37a	7.27b
brothy f.	2.58a	5.01b	brothy f.	3.44a	3.56a	garlic f.	5.84a	7.44b
creamy f.	1.71a	4.46b	other f.	0.26a	0.23a	lemon f.	1.92a	2.90a
other f.	0.15a	0.16a				creamy f.	2.81a	2.60a
sweet f.	3.31a	5.22b	sweet f.	2.24a	3.32b			
salty t.	2.10a	1.88a	salty t.	2.22a	2.40a	salty t.	1.85a	1.89a
			sour f.	2.73a	4.20b	pungent f.	1.69a	2.35a
			tart t.	0.85a	1.00a			
overall quality	7.89a	8.29a	overall quality	7.86a	8.63a	overall quality	7.23a	7.85b

o., odor; f., flavor; t., taste; a, b, values bearing different letters are significantly different at  $p < 0.001$ .

A, liquid pea ravioli; A-1, cream of green pea; B, tomato soup spaghetti; B-1, pure tomato soup; C, spinach foam; C-1, spinach dip

Intensity of many flavor attributes in traditional dishes was estimated significantly higher. Cream of green pea soup (A-1) had higher intensity of brothy, creamy and sweet flavor, tomato soup (B-1) higher notes of tomato, sweet and sour flavor while spinach dip (C-1) had higher intensity of garlic flavor ( $p=0.001$ ) (Table 4). Other attributes differentiated not significantly between traditional and molecular dishes. In the case of green pea dishes (A, A-1) and tomato dishes (B, B-1), the differentiation of individual attributes defining their sensory quality, statistically did not differ in the overall quality of these dishes in both versions ( $p \geq 0.05$ ). Overall quality of traditional spinach dish (sample C) was significantly higher ( $p=0.0001$ ) than the molecular version (C-1) as a result of higher intensity of odor (spinach and creamy smell), green color, consistency (density, fluffiness), as well as flavor (garlic).

The lower liking scores for odor and flavor of the molecular versions may be the result of the interactions between flavor or aroma compounds and polysaccharides used to give the shape or form of dishes (gelling agents in ravioli and spaghetti, stabilizer in foam). Similar observation was made by TRAYNOR *et al.* (2013) who studied various food-pairing combinations and emphasized that complex synergistic or antagonistic interactions between food matrices and volatile compounds may occur and affect the hedonistic rating of the new combination. According to FAVALLI *et al.* (2013) in new developed product it is possible to change the appearance and consistency characteristics as long as it does not change the ingredients and provides the same level of retro-nasal attributes intensity. In this study, molecular dishes were less liked than traditional ones. Moreover, analysis of the sensory profiles revealed significantly higher or comparable intensity of most quality factors relating to odor, color, consistency (density, smoothness, fluffiness), and flavor in traditional dishes. This is related to higher content of ingredients such as butter and cream in those dishes. For example, more intense flavor and odor of pure tomato soup may be caused by presence of fat in it because fat has influence on mouthfeel, forms deliciousness and contributes to the release of a scent from food products.

### 3.4. Consumers' feelings toward evaluated dishes

Consumers were also asked to indicate the feelings accompanying them in relation to evaluated dishes (Table 5). In general, modernist cuisine evoked in consumers more emotions (35.3%) than traditional one.

**Table 5.** The feelings of consumers in relation to the assessed dishes.

Sample dishes	The feelings of consumers (Percentage of respondents' answers)						
	liking	surprising	arousing curiosity	innovative	traditional	challenging for sense	being skeptical
A – liquid pea ravioli	37	17	28	13	6	10	28
A-1 – cream of green pea	59	4	16	3	41	4	11
B – tomato soup spaghetti	17	54	59	54	5	22	13
B-1 – pure tomato soup	50	6	5	6	69	4	7
C – spinach foam	21	59	50	51	3	23	20
C-1 – spinach dip	65	3	9	3	47	14	10

Most of the molecular courses were associated by consumers (about 50%) with feelings, like 'surprising', 'arousing curiosity', 'innovative' and 'liking'. A small percentage (about 20%, depending on dish) of consumers indicated feelings as: 'challenging for sense' and 'being skeptical'. As expected, majority of consumers associated traditional dishes with feelings: liking (50-65%) and traditional (41-69%). Molecular dishes that use gelification or foaming process were assessed as 'surprising', 'arousing curiosity', and 'innovative', as 50-59% of surveyed consumers indicated. The dish made by using spherification process was seen by the majority of respondents (28-30%) as 'liking', 'arousing curiosity', and 'being skeptical'. Dishes, which were perceived by largest percentage of consumers (>50%) as arousing curiosity, surprising, and innovative (tomato soup spaghetti, spinach foam), were also less liked.

Almost 88% of respondents (n=150) would like to taste different molecular courses in the future, although, most of them chose traditional ones in the paired comparison test.

It may be explained by the most frequent feelings related to modernist cooking, i.e. arousing curiosity, surprising, as well as liking and innovative. This is all the more interesting because consumers taking part in analogous research conducted by MIELBY and FROST (2010) would not like to consume the same molecular cuisine dishes at another occasion. This indicates that consumers seek a new food experience. Additionally, differences in the responses may be associated with different groups of subjects. Consumers who have participated in this study were young, mainly under 25 years old so more inclined to culinary experiments. MIELBY and FROST (2010) emphasize the relationship between molecular dishes and sensations they evoke.

Today, consumers are in search of something more than solely food, which is no longer considered as satisfying physiological needs, but could also bring emotional benefits, the pleasure of tastes (MÄRKUT *et al.*, 2014).

## 4. CONCLUSIONS

The study has shown significant differences between the sensory quality of molecular and traditional cuisine. Higher degree of liking of traditional dishes, as well as more intense typical flavor and odor has been noted ( $p < 0.05$ ). Consumers chose traditional dishes and indicated flavor as the most important sensory trait. The largest percentage of consumers associated modernist cuisine with feelings like: 'arousing curiosity', 'surprising' and 'innovative'. Most of them showed their willingness to try other molecular dishes in the future, although prefer traditional ones. The evaluation of molecular courses is not easy because the idea of creating them is based on constant novelty and uniqueness of dishes, hence, is described as 'haute cuisine'. However, our results revealed a positive attitude of consumers towards molecular dishes, their moderately high sensory-experience ratings and openness towards new ideas. The juxtaposition of molecular cuisine assessment at laboratory environment and restaurant setting, as well as cluster analysis to identify target consumer segment seem to be good idea for the further studies.

### 4.1. Practical implications

The results of this study emphasize the possibility of molecular cuisine use to vary and extend the range of menu items in restaurants. Modernist cuisine as an element of traditional dish might make its more interesting, surprising and arousing curiosity. Such a dish beside the nutrition role would evoke more emotions and therefore draw attention of more consumers.

## 4.2. Limitations

Some limitations of our study need to be addressed. Although presented consumer attitude applies to evaluated dishes, the authors tried to choose the most popular techniques of molecular cuisine among chefs. It should be emphasized that the idea and principle of this cuisine is the creation of innovative, unique dishes, which are different at each catering establishment and often rotated in the menu.

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