

# Salt Reduction: Translation of Consumer Expectations into Wishful Taste Product Attribute

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**Abstract**—Food industry has responsibility to improve their products in terms of salt content as consumers hold them responsible for their excess consumption. Data suggests that personal preferences in salt liking would influence the acceptance of salt reduced food product. Replacing table salt with a new and innovative salt substitute pose a great challenge for salt reduced food product, from technological and sensory point of view. In this paper specific circumstances were described that influenced a decision for invention of new table salt substitute as a solution for reducing salt content and for the first time, the sensory results of 25% reduced salt soup made with the innovative ingredient. For the two thirds of the participants (n=101), reduced salt soup was adequate in saltiness and good overall palatability, without off-flavour. These promising results give a solid baseline for further application of a new salt substitute in a various food products range without compromising the taste.

**Index Terms**—salt reduction, innovative salt substitute, food product, consumers, sensory evaluation

## I. INTRODUCTION

A solid body of scientific evidence have shown relation of excessive salt consumption with rise of blood pressure increasing the risk of cardiovascular disease (CVD) and renal disease, indirectly related to obesity. Worldwide, average salt intake in most countries is approximately 9 to 12 g/day, with many Asian countries having mean intakes more than 12 g/day [1].

There are three main sources of dietary salt: commercially prepared or manufactured food (75%), naturally in food (13%) and discretionary salt (12%) [2]. Therefore, lowering of salt intake is public common goal of all stakeholders: national agencies, food industries and consumers targeting a max. salt intake is 5 g/day according WHO recommendation.

Recent paper has revealed that although consumers perceive themselves and food industry as the most responsible for salt reduction [2], sensory preference for salt liking would be a main trigger with habituation to a

reduced salt diet. Those who are used to consume higher amount of salt prefer saltier foods while those with a lower salt intake eat less salty foods [3, 4].

However, the first contact with the food product is in a grocery store through label messages. Croatian studies conducted on a representative sample have shown that among of the one third so called “label users”, the information about salt/sodium at back-of-label were read very rarely (less than 0.5% of sample), and for the majority of population who never read nutrition label, health problems would be the main motive starting with reading the nutrition label [5], [6].

However, it is likely that a specific cultural background could considerably differentiate personal preferences in salt liking and reading label practice. Therefore developing reduced salt product is rather complex process. Knowing that salt has influence on taste, safety, water activity, appearance and the fact that any change in salt quantity or composition would probably challenge consumer liking and price sensitivity at least, knowledge and expertise of food product developers would be crucial for the consumer acceptance of salt reduced products.

The process of reducing salt in food product (reformulation) has basically three possible approaches: 1. “Reduce” salt quantity - that is connected with gradual reduction of salt (no changes in recipes) and/or use of taste enhancers; 2. “Replace” salt - focused on increased use of spices, mineral salts (e.g. potassium chloride (KCl), mineral concentrates, magnesium sulphate (MgSO<sub>4</sub>); and 3. “Remove” - that remove the addition of salt completely (is simple to do, if only salt is added purely for taste; on the other side could ruin the taste and shelf life) [7].

Potassium chloride (KCl) and numerous of potassium chloride (KCl)-based salt substitutes are among the most frequent used solution that could instantly replace table salt (sodium chloride (NaCl)) and reduce sodium content [8]. However, potassium chloride (KCl) is characterised by the off-flavour, metallic and bitter taste.

To choose the best reformulation approach, it is necessary to evaluate the role of salt in food products, understand consumer preferences and a specific taste mark connected with brand. Consequently, a Croatian

food processing company have decided to start reducing salt through a two-stage approach. At first stage, the effort was focused in development of a new and innovative salt substitute that could completely replace table salt without unwanted sensory effect, while at the second stage the innovative ingredient was applied to developed salt reduced food products.

The objectives of this paper were to reveal the circumstances that influence the invention of new, "tailor-made" salt substitute and to investigate consumer's sensory liking of a new food product 25% salt reduced that has been developed with the new and innovative salt substitute.

## II. MATERIALS AND METHODS

### A. Participants

#### 1) Preliminary studies

There were two preliminary studies conducted in year 2015. First preliminary study was descriptive sensory analysis conducted with 9 trained sensory assessors at food processing company Laboratory for sensory analysis in Koprivnica, Croatia. The panel passed through the intensive training course on salty and umami tastes during period of six months and have been specialized for savoury tastes [10], [21], [22].

Following the first one, a second preliminary study was conducted with general population through focus group sessions at the Faculty of food technology and biotechnology University of Zagreb, Croatia. In total, 23 participants were recruited upon familiarity with the topic of food and nutrition, and approximately equal distribution of gender and age. Participants in sensory evaluations were invited by email invitation. They were divided in two groups based on their ages. Twelve participants (52%) were part of two focus groups ages up to 25 years while eleven participants (48%) between 26 and 55 years were part of the rest two. Altogether, 12 were female and 11 male subjects. All subjects signed participation consent.

#### 2) Main study

In a year 2017 a total of 101 Croatian subjects from food processing company aged between 18 and 55 years (84 females and 16 males, mean age 41 years) were selected to participate in sensory evaluation. They had little or no experience in sensory assessments (naive panel) and were reported as regular or occasional consumers of specific type of products appointed in a study. Subjects were selected based on preferences on savoury tastes and consumption of soups in general. All selected subjects were part of preselected group of volunteers for sensory evaluations upon email invitation. For the purpose of this sensory assessment participants were randomly divided in a 12 groups, each group had on average 8 participants.

### B. Samples

#### 1) Innovative ingredient – salt substitute 35% sodium reduced

Previously conducted sensory testing of a wide number of commercially available salt substitutes did not reach

company's taste expectation (data not shown). In order to realize company's Nutritional strategy goals in terms of reducing salt without compromising the taste, a unique combination of sodium chloride (NaCl), potassium chloride (KCl) and mineral salts - 35% less sodium product was invented (PCT patent application No. PCT/HR2015/000016) [9]. Before its usage, an innovative ingredient was approved in accordance with good laboratory practices and other legal food standard (data not shown here).

Hereinafter referred to as an innovative ingredient.

#### 2) Soup samples

With a purpose to test sensory liking of a new reduced salt product made with an innovative ingredient, two dehydrated cream vegetable soups (samples) were prepared in laboratory. "Reference soup" was made with addition of table salt and "salt reduced soup" with an innovative ingredient that fully replaced table salt. The overall ingredient's list for dry "reference soup" was: wheat flour, non-fat milk powder, table salt, corn starch, dry broccoli, palm oil, potato starch, yeast, sugar, dry onion, spices while for the "salt reduced soup" was: wheat flour, non-fat milk powder, corn starch, dry broccoli, palm oil, table salt, potato starch, yeast, sugar, potassium chloride, dry onion, potassium-magnesium citrate, spices.

Before testing, both soups were rehydrated with 87.5% tap water and 12.5% milk (2.8% mil fat content) and cooked for 8 minutes. Every participant was served with 100 ml of soup, resulting in 1g salt/100 ml in reference soup, and 0.4 g salt/100 ml in salt reduced soup. For every session fresh volume of soup was prepared.

A small porcelain bowls were used for presentation to each participant, marked with three digit numbers according to the best practices in sensory laboratories. Samples were presented in a random order to each participant.

Because of application of innovative salt substitute, sensory evaluation presented in this paper was blind tested (reference soup and salt reduced soup), as taste perception of reduced salt product was of primary interest.

This principle for sample presentation was exactly the same in all studies with consumers.

### C. Procedure

First preliminary study was descriptive analysis, specifically Quantitative Descriptive Analysis® (QDA) held for the purpose of generating set of terms that describe differences in intensity between products [10] and evaluating samples for profile defining. According to the taste profile that is relevant to salty taste, most important terms were chosen for main study questionnaire development. Selected sensory attributes were flavourness, saltiness and off-flavour.

Second preliminary study was qualitative consumer research, specifically focus groups mainly used for problem clarification, identifying opportunities, generating ideas and hypothesis from consumer perspectives [10, 12]. Focus groups conducted with purpose to identify preferences for salt uses in food preparation and consumption, and their opinion on salt

reduction by using salt substitutes. Discussion was held at the beginning of the focus groups after which tasting part was held with the same soup samples and according to before described methodology. In sensory assessment conducted by trained panel samples were simultaneously presented. Simultaneously presented samples in descriptive sensory evaluation enable better comparison and discrimination, and more reproducible results [23]. In contrary, participants of focus groups got samples monadically which means one sample at a time [23] after each discussion session.

The participants of both preliminary studies have been excluded from the main study. In this paper, only results relevant for the main study were presented since the comprehensive study was conducted with the intent to test sensory quality in an unambiguous way.

Sensory evaluation for main study was performed during 3 days in 12 sensory sessions, each lasted for about 15 minutes. Affective sensory methods were used for main study. (1) Hedonic test, method for overall liking judgement which use a balanced 9-point scale with textual explanation of scale point labels that represent psychologically equal changes in hedonic tone. [10]. (2) Just-about-right (JAR), scale designed to measure the consumer's reaction to a specific attribute, in our study was used for "saltiness" and anchored with "Not salty enough" and "Much too salty" at the ends and "Just-about right" in the centre [10]. (3) Category scale as Likert scale are usually used for opinions and attitudes, based on someone's agreement or disagreement with a statement about the product [10]. In this study, Likert scale was used for examination of "flavourness" with scale points from 5-very pleasant to the 1-very unpleasant. The other type of category scale in this study was used for off-flavour presence judgement with simply "yes" or "no" answers. (4) Preference tests, choices involving comparisons between two samples [10], [11].

Each sensory panel session started with short explanation by panel leader who gave instructions on sensory protocol and devices uses. Samples were presented monadically, questionnaire was prepared online and presented via tablet computers. Each sensory panel session was conducted in laboratory for sensory evaluation, according to general requirements for sensory analysis, with minimum distractions that can lead to biased results [13].

#### D. Data Analysis

##### 1) Descriptive analysis

Data were analysed by means of paired samples t test for difference between attributes. Results were considered significant at the level of  $p < 0.5$  [10].

##### 2) Focus groups

Qualitative study was performed on the central location with 23 participants. Quantitative data collected in the study were for overall liking (Hedonic scale), saltiness using JAR scale (Just About Right), presence of off flavour (Yes/No category scale) and flavourness using 5 point Likert scale (1 extremely unpleasant, 5 extremely pleasant). Data were analysed by means of frequency (mean, standard deviation) and paired samples t-test.

Qualitative data were analysed by using method of content analysis. [10]

##### 3) Consumer study

Significant differences in overall liking between two samples (reference soup and salt reduced soup) were analysed using paired samples t-test. JAR data were analysed by using paired samples t test, after recoding of the scale, and penalty analysis was used to establish the influence of saltiness attribute on overall liking of the products [27]. Preference data were analysed by non-parametric McNemar test for related samples. Results were considered significant at the level of  $p < 0.05$ . The data analysis was performed in IBM SPSS v. 19.0 (IBM SPSS Inc., Chicago, IL, USA).

### III. RESULTS AND DISCUSSION

Due to the application of an innovative salt substitute, sensory evaluation showed in this paper was blind tested as taste perception of reduced salt product was of primary interest. Therefore, number of sensory assessments were performed according to different methodologies to assure qualitative profile of products and salt substitute itself.

Although, preliminary studies had shown promising results, as it revealed more flavourness and no off-flavour in the salt reduced soup, still many uncertainties about overall acceptability of salt reduced soup existed. Many studies in the past showed that for majority of consumers less saltiness meant unpalatable and tasteless [18]-[20].

#### A. First Preliminary Study – Descriptive Panel

Sensory panel developed profile that describe samples with twelve characteristics: colour, odour of vegetables, spiciness odour, dairy odour, saltiness, vegetable flavour, dairy flavour, off-flavour, creaminess, texture and flavourness. Paired samples t test indicated no significant differences between samples in all attributes. (Fig. 1). Participants of first preliminary experiment, trained sensory panel perceived slight differences in saltiness between samples.

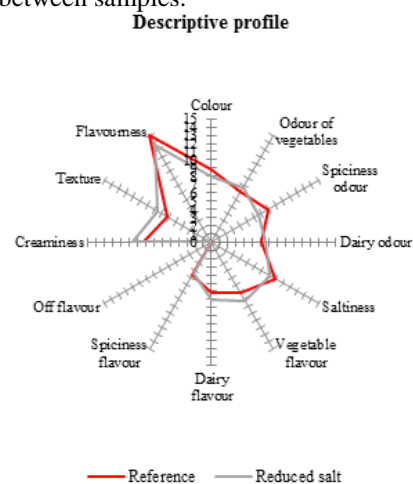


Figure 1. Comparison profile between reference and salt reduced soup

#### B. Second preliminary study – Qualitative Consumer Research – Focus Group

Taking into account lower salt quantity in sample with innovative ingredient (salt reduced soup), it was expected

that focus group participants would detect differences between reference and salt reduced soup that could have impact on acceptability, particularly participants with higher daily average salt intake. Indeed, participants perceived differences between soup samples in a salt intensity but also confirmed adequate saltiness in salt reduced soup, underlying its mild and natural flavour and overall acceptance.

They pointed out flavourness similar to the reference soup but lacking in spiciness, fullness, naturalness and flavour character of reduced salt soup, indicating the space for recipes improvement (Fig. 2). Off-flavour, usually common for salt substitutes, was not perceived (Fig. 3). Previous research [24] indicated that different external information, in this case discussion on salt perception, could potentially influence the results of consumers. Therefore, research should be extended on a larger group of participants using quantitative test methodology.

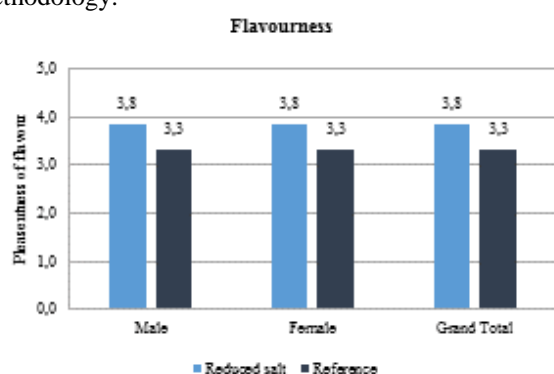


Figure 2. Differences in perception of pleasantness of flavour between male and female subjects, rated on a Likert scale (1 not pleasant, 5 very pleasant) in a preliminary experiment.

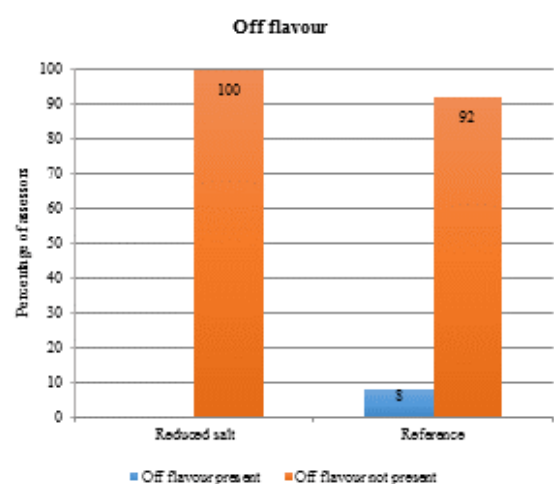


Figure 3. Percentage of subjects that rated the presence of off flavour in samples in preliminary experiment.

### C. Main study

Results of consumer study corresponds with former, preliminary studies, as the most participants perceived distinct salt intensity in samples, more specifically less saltiness in salt reduced soup.

Saltiness of samples was rated on a 5 point JAR (Just About Right) scale, with 1 being not salty enough, 3 just

about right and 5 much too salty. Salt reduced soup was evaluated as having adequate level of saltiness, while more than half of respondents evaluated reference as right level of saltiness and about third respondents think it is lower than desirable (Fig. 4). There was no statistical significance between samples however, and penalty analysis showed negligible influence of saltiness on preference.

The main study should give answers whether consumers could perceive differences in saltiness. Besides, it is unknown if consumers, as they are usually less aware of recommendation, preferred less salty taste. Previous study revealed that knowledge on salt consumption had not affected reduction in salt intake [25]. For 68.3% consumers, a salt reduced soup were adequate in saltiness while a reference soup was less favourable in saltiness judged by the 56.4% consumers (Fig. 4). This was not a surprise as the salt replacer utilization is 1:1 for table salt, and its primary characteristic was to retain intensity of saltiness from regular product. Previous published data have mentioned that strategy of reducing salt by using salt replacers was the acceptable approach in rapidly reduction without influencing well known and preferable taste [14], [28]. Results of the main study for saltiness confirmed those in preliminary studies

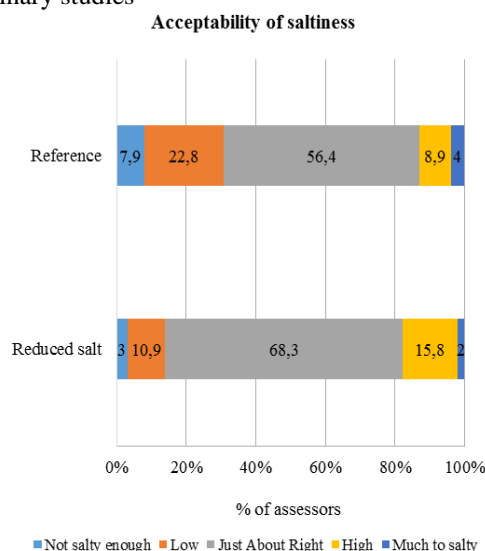


Figure 4. Percentage of assessors rating of acceptability of saltiness intensity by using JAR scale in main experiment

Flavourness was evaluated on 5 point Likert scale (1 very unpleasant, 5 very pleasant). Both soup samples were rated as equally pleasant with no significant difference between them, also there was no difference between male and female respondents (Fig. 5). As results have shown an innovative ingredient-salt substitute did not have impact on perceived flavourness of salt reduced soup that is important for maintenance of products' success on market. Uses of salt in adjustment of taste and flavourness has been well documented [29], [30] and critical point of reduced salt products is flavour quality as result of sensory interaction between aroma and taste [31]. A literature data were confirmed within results presented in this paper.

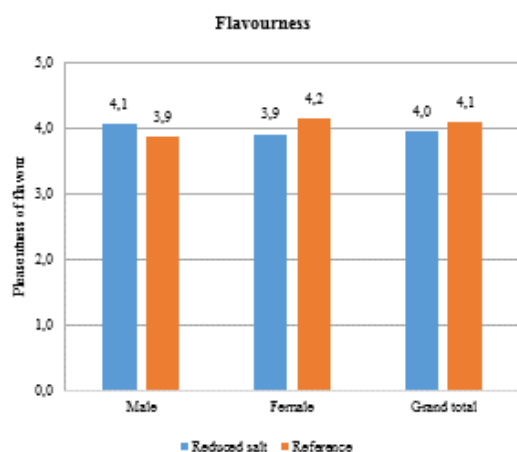


Figure 5. Differences in perception of pleasantness of flavour between male and female subjects, rated on a Likert scale (1 not pleasant, 5 very pleasant) in main experiment.

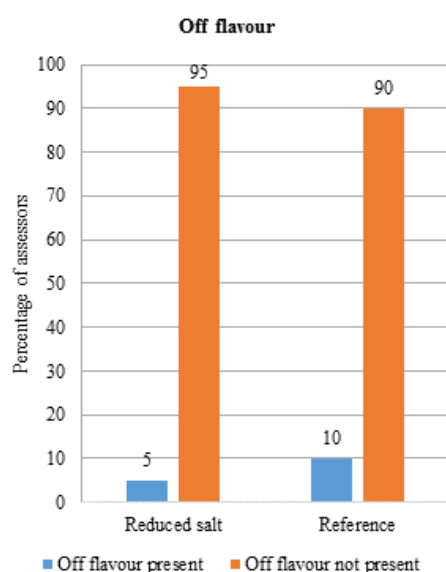


Figure 6. Percentage of subjects that rated the presence of off flavour in samples in main experiment.

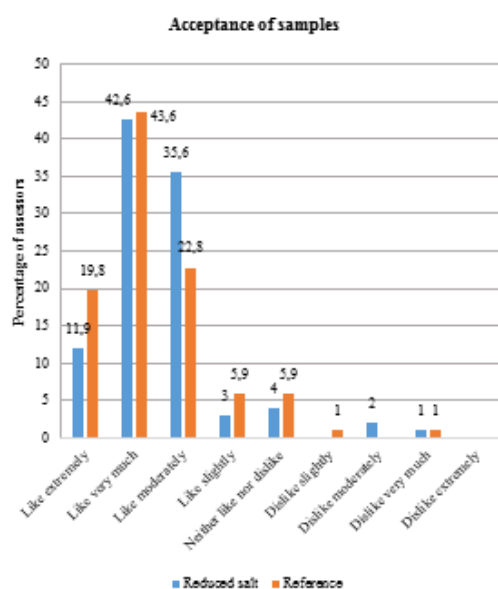


Figure 7. Distribution of ratings for acceptability of samples using hedonic scale in main experiment.

Off flavour was evaluated as present or not. Although very small number determined presence of off flavour, more respondents found it in reference soup than in salt reduced soup (Fig. 6). There was no significant difference between soups. Off-flavour was not subject of concern as it has been confirmed that it was not present in studies from the previous study (data not shown).

Acceptance was evaluated on 9 point hedonic scale. According to mean values samples were evaluated as very acceptable. There was no significant difference between soup samples (Fig. 7 and 8).

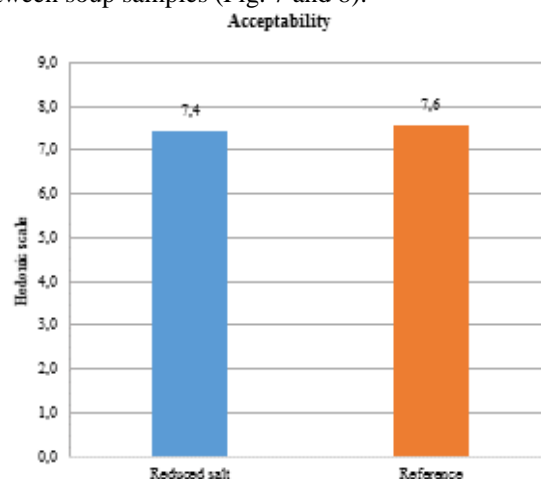


Figure 8. Acceptability mean value of samples in main experiment.

Results for preference were in accordance with the acceptability, preference for samples was almost the same with no significant difference between them. Reference soup was slightly better evaluated than salt reduced soup (Fig. 9).

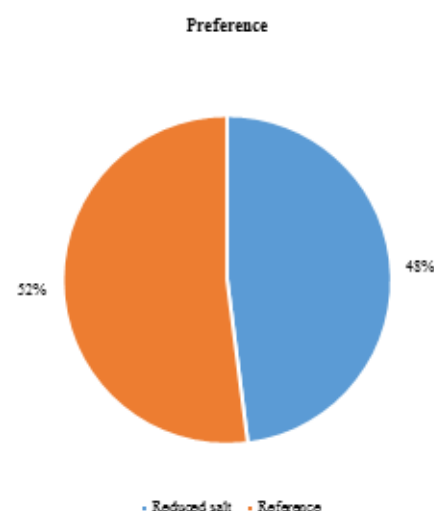


Figure 9. Overall preference of samples, expressed with percentage of assessors, based on the results of main experiment.

Taste as a very important factor in food selection may not be as important for health conscious consumers as it has been shown in earlier studies. Nevertheless, among culturally different consumers, "less salt" claim on front-of-label implies different perceptions and for some of them it could have meaning of less tasty [14]. As many consumers do not want to sacrifice foods' palatability,



finding solution that could solve double problem, lowering salt content and keeping wishful taste characteristics, could help with product acceptance [26].

Salt substitutes could be an adequate solution for salt replacement [8] preferably for products with complex flavour profiles as this could suppress bitterness and off-flavours elicited by salt substitute ingredients [16]. In earlier studies, salt substitutes were mostly tested on cheese, bread, meat products, soup and ready to eat meals [17]. Salt reduction by salt substitute could be done abruptly by using sensory evaluation methodology, primary for taste quality, as confirmation.

Although, preliminary studies had shown promising results as it revealed more flavourness and no off-flavour in the salt reduced soup still a much uncertainty about overall acceptability of salt reduced soup existed.

Nevertheless, all results presented in this paper fitted very well together and indicated on well managed research process with consumer's opinion as a final point. Consumers' sensory judgement gives directions for upgrading qualitative performance of specific food product with goal to help in recipes improvement process that is necessary in managing every products during their life cycles.

#### IV. CONCLUSIONS

This paper showed the food industry possible approach in reducing salt content in food product. The invention of a new salt substitute is time and expert demanding. Therefore to perform that, capacity for research and development should be carefully evaluated at the beginning. Then, the value of invention should be objectively considered, particularly in terms of their commercial application.

Fortunately, selected approach have shown the promising results on both sides - an originality of invention was approved through the world patent acceptance and at the side of consumer's taste acceptance demonstrated through multi-layered sensory assessment presented in this paper.

An comprehensive sensory testing was performed in order to prove the qualitative performance of the innovative ingredient - salt substitute, developed to help food industry's challenges in a reduction of salt quantity. No perceived off-flavour was noticed in the salt reduced soup, while wishful intensity of saltiness was confirmed among majority of consumers.

Although promising results of an application of an innovative ingredient gives a real opportunity in resolving issues usually connected with less palatable, salt reduced products, these results have primary referred on soups segment. A further analysis is need to evaluate the potential of innovative ingredient as a salt substitute solution at a wider range of product (e.g. meat products, bakery products, milk product etc.) and among consumer's with different cultural background. Furthermore, the messages about the low salt content on product's front-of-label is the next important step in commercialisation of salt reduced products.

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