Influence of salt reduction on flavour release in ready-to-eat meals

CÉCILE RANNOU[1], Florence Texier[1], Philippe Courcoux[2], Véronique Cariou[2] and Carole Prost[1]

[1] *Oniris, UMR CNRS GEPEA 6144, Flavour Group, BP82225, 44322 Nantes cedex 3, France*
[2] *StatSC, Oniris, INRA, BP82225, 44322 Nantes cedex 3, France*

Abstract

Salt reduction in food is becoming a major concern for public authorities since a high sodium diet is associated with an increased risk of hypertension and obesity [1,2,3,4]. As convenience products and ready-to-eat meals are one of the main sources of dietary sodium, the food industry is encouraged to produce low-sodium formulations. However, salt is a well-known flavour enhancer and its reduction could modify the release of volatile compounds, thereby affecting flavour perception. In this study, a salt reduction of 40% in a meal composed of chicken, pasta and cheese sauce significantly impacts its flavour perception evaluated in sensory analysis compared to the reference meal with no salt reduction. The decrease of flavour intensity could be related to the decreased amount of terpenes as these compounds are known to be highly odour-active.

Introduction

Sodium chloride, usually referred to as salt, provides about 90% of people's dietary sodium intake [1]. The World Health Organization recommends a maximum salt intake of 5 g/day for adults. However, in the industrial countries, the mean sodium intake is generally higher [2]. Dietary sodium intake mainly originates from processed foods (75-80%), from non-processed foods (5-10%), and from the salt added during the preparation of meals or at the table (10-15%) [1]. A salt consumption higher than the physiological needs is known to increase blood pressure, leading to the development of noncommunicable diseases, such as hypertension, cardiovascular diseases or coronary heart disease [1,2,4]. Lowering the salt intake of individuals is one of the main challenges for authorities to prevent health diseases [5].

During industrial food processing, salt is largely used as a flavour enhancer. A reduction of its amount in foods may modify their organoleptic properties, especially taste. However, taste has been pointed out to be one of the main drivers of liking, which motivates consumers to purchase a product [6]. Considering the pressure of the public authorities on the food industry to reduce salt in their products, the main challenge is to formulate food with lower sodium content while maintaining satisfying organoleptic qualities [6]. Processed foods are particularly rich sources of sodium. In Europe, the main sources of sodium are bread and cereal products, delicatessen, sauces and condiment, ready-to-eat meals, cheese, soups, pasta dishes and pizzas [1,3,7]. The consumption of convenience foods and ready-made meals is steadily increasing, as is the development of obesity and other diseases related to high sodium intake. This phenomenon is related to our modern life style which involves less time spent for meal cooking [8].

Many solutions have been tested to reformulate foods with lower sodium content while maintaining an acceptable organoleptic quality. Each solution must be adapted to the type of food, as salt may also have a technological role, especially for microbial safety [1,9]. For ready-to-eat meals, the solutions tested involve direct salt reduction, use of substitutes such as potassium chloride and flavour enhancers such as yeast extract and

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addition of natural flavour enhancers such as aromatic herbs [1,10]. In fact, the study of odour-taste interactions could compensate salt reduction with the use of aromas congruent with salt perception [10,11].

Many studies were conducted to test solutions to compensate salt reduction and check their acceptability by consumers, however only a few were performed to characterize the impact of salt reduction on the flavour of food, especially ready-meals, with both instrumental and sensorial methods. As salt is a well-known flavour enhancer, a reduction of its amount could modify the release of the volatile compounds and thus flavour perception. In this study, a ready-to-eat meal composed of chicken with pasta and cheese sauce with various levels of salt content was chosen to study the impact of salt reduction on sensory perception as well as on volatile compounds release. The aim was to characterize the modifications in the aroma profile due to salt reduction of ready-to-eat meals by means of a descriptive profile to determine the effect of salt reduction on the sensory properties, and, secondly, to identify if modifications in the volatile compounds can be observed due to salt reduction.

Experimental

Materials

Ready-to-eat meals were produced containing pasta (38%), chicken (24%) and cheese sauce (38%). Various salt levels were tested: 100% salt (0.80g salt/100g food), 80% salt (0.64g salt/100g food), 70% salt (0.56g salt/100g food) and 60% salt (0.48g food/100g food).

Sensory analysis

A panel consisting of 21 trained assessors (23-55 years) was recruited. Sensory analysis took place in a sensory analysis room equipped with sensory booths. The 4 samples were conditioned in isotherm boxes and delivered at 63°C to the panellists. The samples were presented in a randomized order and identified with a three-digit code. A ranking test on 11 attributes was performed. The attributes were chosen to describe odour (O), texture (T) and flavour (F). A Friedman test (α=5%) was applied on these results.

Chromatographic analysis

Volatile compounds were extracted using HS-SPME (Headspace Solid Phase Micro Extraction). The fibre used was 1cm Car/PDMS 85µm. Samples were weighed (5 g) in a 20mL vial. The equilibrium phase lasts 15min at 49°C. The extraction phase lasts 50min at 49°C. After extraction, the volatile compounds were injected in the GC-MS (column DB-WAX). Injector was maintained at 260°C. The program temperature ranged from 40°C (5min) to 230°C (10min) at 5°C/min. Identification of the volatile compounds was performed with comparison of the Kovats linear retention indices (LRI) with the literature, comparison of the mass spectra with a database and standard injection. Relative areas were used for semi-quantification. Comparison of the amount of each volatile compounds in each sample was performed with one-way analysis of variance (α=5%) followed by Least Significant Difference test.

Results and discussion

Sensory properties of pasta/chicken/cheese sauce meal

A sensory characterization of the 4 samples of pasta/chicken/cheese sauce meals was performed (figure 1).

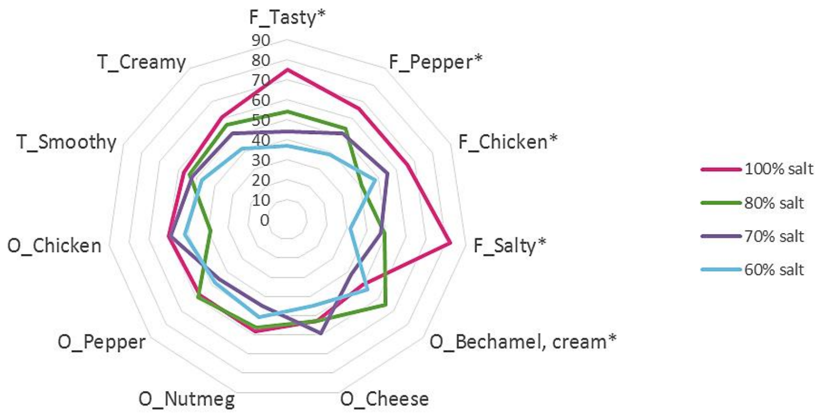

Figure 1: Sum of ranks computed for each sample and each attribute. Significant differences between samples are indicated by an asterisk (α=5%). Different letters mean significant differences.

Differences between the samples were mainly observed for the flavour in mouth. The control 100% salt was always perceived more aromatic than the salt-reduced samples. As expected, the salty taste obtained significant different scores between samples. Moreover, the 3 others flavour attributes (F_Pepper, F_Chicken, F_Tasty) were also impacted by salt reduction, emphasizing its role on flavour release. However, no differences were perceived for texture and odour, except for the odour of béchamel. Such interactions between taste and aroma may be explained by physico-chemical, physiological and psychological interrelationships [12].

A characterization of the aroma volatile compounds was performed to explain the results observed in sensory analysis. Chromatographic analysis revealed that the samples had the same total number of volatile compounds (82) varying only in quantity. Volatile compounds belong to various chemical classes. The most significant differences between samples occurred with respect to terpenes, with a decrease of their concentration associated with the salt reduction (Table 1).

Table 1: Sample means of the quantity of terpenes identified in the 4 ready meals with various salt content (expressed in area x10^5/g of product). Superscripts refer to results from post-hoc LSD tests associated with each volatile com-pound (α=5%). When identical, means are not significantly different.

Volatile compounds	*LRI*	*100% salt*	*80% salt*	*70% salt*	*60% salt*
α-pinene	1026	5,3 (7)^{a}	5,3 (7)^{a}	4,5 (3)^{b}	4,4 (5)^{b}
β-pinene	1111	6,5 (9)^{a}	4,7 (10)^{b}	5,0 (4)^{b}	5,2 (8)^{b}
Sabinene	1125	5,2 (7)^{a}	3,1 (10)^{ab}	3,4 (4)^{b}	2,9 (9)^{c}
δ-3-carene	1154	5,8 (6)^{a}	4,6 (13)^{b}	4,7 (8)^{b}	4,9 (3)^{b}
β-myrcene + l-phellandrene	1171	10,3 (3)^{a}	9,5 (9)^{ab}	8,7 (2)^{b}	9,2 (7)^{b}
α-terpinene	1186	7,0 (8)^{a}	5,9 (11)^{b}	5,4 (4)^{b}	5,8 (4)^{b}
d-limonene	1205	30,1 (3)^{a}	23,5 (8)^{c}	26,8 (7)^{b}	28,9 (4)^{ab}
β-phellandrene	1209	8,4 (11)^{a}	6,1 (10)^{b}	5,9 (5)^{b}	5,3 (5)^{b}
γ-terpinene	1238	12,4 (5)^{a}	10,4 (10)^{b}	9,6 (3)^{b}	10,8 (4)^{b}
p-cymene	1268	13,2 (10)^{a}	10,4 (9)^{b}	9,8 (7)^{b}	10,6 (5)^{b}
α-terpinolene	1279	4,5 (5)^{a}	4,1 (12)^{ab}	3,8 (4)^{b}	3,1 (6)^{c}
4-terpineol	1601	17,5 (3)^{a}	16,1 (4)^{b}	16,0 (2)^{b}	16,4 (5)^{ab}

The presence of terpenes, known as highly odour-active compounds originating from natural products, may be explained by the use of pepper and nutmeg in the sauce. Among the 15 volatile compounds with significant higher concentration in the 100% salt sample 12 are terpenes. Indeed, the impact of salt on the release of the volatile compounds, known as the “salting out” effect, is particularly noticeable for terpenes. This latter aspect may explain the increase of the intensity of the flavour attributes F_Pepper and F_Tasty perceived by assessors in the sensory analysis for 100% salt sample. Similar results were obtained with tomato soups rich in vegetables [6]. Our results show that terpenes are particularly sensitive to salt reduction even when natural products are present in very small quantity in a complex matrix, and these modifications are perceived by consumers.

To improve the nutritional properties of processed foods, salt reduction is strongly advised. However, such a salt reduction might impair the organoleptic quality of food, resulting in a loss of aroma. With regard to cheese sauce-topped chicken and pasta dishes produced within this study, sensory analysis indicated that a salt reduction beyond 20% is perceived by assessors. A characterisation of the volatile compounds revealed that the aroma loss is mainly due to the decrease of the amount of terpenes which was associated with salt reduction (r^2=82% without d-limonene). These compounds, generated by plants, are highly odour-active, and play a significant role in the global aroma of the dish. The complementary use of sensory and instrumental analyses allows us to identify those volatile compounds responsible for aroma loss and permits to consider solutions to compensate it. Indeed, the increase of pepper or nutmeg in the recipe may be an efficient solution to increase the content of terpenes, as well as the use of other herbs and spices or salt-associated flavours [11]. Further sensory analysis performed on the various formulations tested may be necessary to determine the most efficient solution to compensate salt reduction and to produce dishes with satisfying organoleptic qualities.

References

1. Kloss L., Dawn Meyer J., Graeve L. and Vetter W. (2015) NFS Journal, 1: 9-19.
2. World Health Organization (WHO) (2012) In: WHO Press, Geneva, Switzerland.
3. AFSSA (2009) In: Rapport de la commission AFSSA
4. He F.J. and MacGregor G.A. (2010) Progress in Cardiovascular Diseases, 52: 363-382.
5. World Health Organization (WHO) (2013) In: WHO Press, Geneva, Switzerland.
6. Michell M., Brunton N.P. and Wilkinson M.G. (2012) Food Res Int, 44: 1036-1043.
7. Kanzler S., Hartmann C., Gruber A., Lammer G. and Wagner K.-H. (2014) Public Health Nutrition 17(11): 2459-2466.
8. Alkerwi A., Crichton G.E. and Hébert J.R. (2015) British J Nutr 113: 270-277.
9. Durack E., Alonso-Gomez M. and Wilkinson M.G. (2013) J Food Safety 33(3):302-312.
10. Liem D.G., Miremadi F. and Keast R.S.J. (2011) Nutrients 3(6): 694-711.
11. Lawrence G., Salles C., Septier C., Busch J. and Thomas-Danguin T. (2009) Food Quality and Preference 20: 241-248.
12. Arvisenet G., Guichard E. and Ballester J. (2016), Food Quality and Preference, 52, 211-221