Sensory evaluation of bread enriched in fibres and minerals designed to elderly

Dida Iserliyska[1], Denisa Eglantina Duta[2], Gabor Zsivanovits[1]

[1]Food Research and Development Institute Plovdiv
[2]The National Institute of Research & Development for Food Bioresources Bucharest
dida_isser@yahoo.com
d.iserliyska@canri.org

Keywords:
flour, dough, bread, fibres, minerals, consumer test degree of elasticity

Abstract. The effect of fibres and minerals on the quality of enriched bread was studied by means of consumer test for acceptance by elderly. Additionally rheological test was performed to determine the degree of elasticity of the enriched dough. The sensory and physical characteristics were established and evaluated.

INTRODUCTION

The demographic estimations show that the population over 80 years of age will increase with 30 % over the next 50 years, due to the increase of life expectancy in context of continue technological development and improved medical-social conditions. The functional concept "healthy aging" mentioned in the European documents and recommend-ations in the field concerns the prevention of specific pathology along with early detection, before the clinical manifestation, medical recovery and social re-orientation/re-insertion of the elderly. The factors that directly and decisively influence the achievement of these goals are: eating-style and food product quality, whose scientific documentation guarantees allow the building of a specific market as well as the elaboration of certain educational and specific political strategies. The main objective of these strategies is to improve the health status of elderly as group of population with proven bioactive deficiency. Basically, this is achieved by modifying the composition of foods to enrich them and consequently improve the situation by providing critical nutrients. Hence adopted new processing protocol of enriched bread to meet the needs of elderly consumers would be a step further in nutrients deficiencies prevention for over aged.

Proper nutrition is an important prerequisite for quality of life, health and welfare. During the life, each person develops their own way of eating, which includes diet, food choices and menu designs. Aging is accompanied by physiological changes, emotional, social and environmental unrecognizable.

Because of the high incidence of disorders in the elderly that interfere with iron absorption efficiency as: post-atrophic gastritis, syndrome gastroectomic, some elderly people have iron available in small quantity. Blood loss associated with hiatal hernia, peptic ulcer, haemorrhoids and cancer non-steroidal as well as the use of anti-inflammatory drugs is common in older people. Zinc influences the health of tissues, especially the skin and is important in immunity. Zinc provides general protection against aging, functioning as an antioxidant (*Gariballa and Sinclair, 1998*).

Inulin is used increasingly for obtaining new foods as bakery products, milk, cereal snacks and beverages due to various reasons: it is a soluble fibre with health benefits as prebiotic, it has low caloric value, it can be used as a substitute for sugar or fat, it is appropriate because diabetics use low GI. Inulin promotes high absorption of minerals, especially calcium (*Kim and others, 2004*) and magnesium; the increase in bone mineral density, reduces the quantities of lymph lipids (e.g. cholesterol and triglycerides) favouring a good heart activity.

Being indigestible carbohydrate, inulin fits well with the current dietary fibre concept. By increasing faecal biomass and high water content removed, it can enhance the functionality intestines. In addition, inulin is classified as prebiotic; prebiotic effect was defined as the ability to selectively stimulate the development and activity of the gut bacterial species (*bifidobacteria* and *lactobacilli* in general) with health benefits (*Meyer and Wolf, 2008). Marteau and colleagues* (2011) demonstrated that supplementation with 15 g inulin improves constipation and quality of life in an elderly population with constipation.

Comparison between the sensory and rheological – texture – parameters have always been a part of the quality surveys for the breads (Jiang *and others*, 2005; Mahmoud Abu-Ghoush *and others*, 2008; Amita R. Shah *and others*, 2006; Lanqin Xia *and others*, 2008; Nyuk L Chin *and others*, 2005). These resources demonstrate similar compression test for different type of sliced breads.

The aim of this work was to develop cereal-based products (bread types and roll types) for elderly and test the acceptance and the texture parameters of the obtained products.

MATERIALS AND METHODS

Materials

Materials for obtaining bread rolls improved in soluble fibres (inulin from chicory) (Figure 1)

– Wheat flour (white flour: 13.8 % humidity, 26 % gluten content, 1.5 mm deformation index; 0.65 % d.w. ash content, brown flour: 14.0 % humidity, 24% gluten content, 1.5 mm deformation index; 1.25 % d.w. ash content, whole wheat flour: 15 % humidity, 23 % gluten content, 2.0 deformation index; 1.75 % d.w. ash content),
– Yoghurt (1.5 % fat content),
– Soluble fibre – inulin (product Fibruline Instant) was purchased from S.C. Enzymes and Derivates S.A. and added to flour in concentrations of 8 %,
– Compressed yeast "Pakmaya" from the market,
– Cooking salt,
– Margarine (commercially available),
– Gluten (1.5 % reporting to the wheat flour amount) and
– Vinegar was used to prepare three types of bread rolls samples.

Materials for obtaining bread enriched with iron and zinc (Figure 2)

- Wheat white flour with ash content 0.42%, moisture 13.8%, water absorption capacity 60.5% (up to 500 B.U. consistency to the dough),
- Lipids 0.07 % dry weight,
- Proteins 11.9 % dry weight,
- Cooking salt,
- Compressed yeast "Gist-Brocades",
- Drinking water,
- Sunflower oil,
- Crystal sugar and
- Na-stearoil-2-lactylat.
- Minerals: Chemically pure and toxicologically safe mineral salts with purity above 99.0% were used: FeSO4*7H2O and ZnCl2 in amounts corresponding to 10% enrichment level to compliment the daily intake (RDI).

Bread markers in that paper

A – white wheat flour enriched with inulin;
B – brown wheat flour enriched with inulin;
C – whole wheat flour enriched with inulin, and second day
D – white wheat flour enriched with $FeS0_4*7H_20$;
E – white wheat flour enriched with $ZnCl_2$ and
F – white wheat flour enriched with the combination of the two salts type

Methods

1. Obtaining the bread rolls improved in soluble fibres.

The bread rolls improved in soluble fibres were obtained using a direct manufacturing procedures follows: white wheat flour/ brown wheat flour/whole wheat flour 100 g, water $40.0x10^{-3}$ m^3; cooking salt 1.5 g, yeast 3.0 g, yogurt 10 g, margarine 1 g, vinegar $0,7 \times 10^{-3}$ m^3, inulin 8 g. Gluten 1.5 g was added to brown/whole wheat flour. The parameters of bread making procedure are shown in Table 1. The fibres were added into the dough during the kneading process. Dough rolls samples were weighed in grams of around 140 g so the finished products reached about 100 g each. Laboratory baking tests for obtaining the bread rolls enriched in inulin were done in the pilot plant of IBA Bucharest (Romania).

Figure 1
Bread rolls enriched in fibres (samples 1-A, 2-B and 3-C)

Figure 2
Bread loaves enriched in minerals (samples D, E and F)

2. Obtaining bread enriched in iron and zinc.

The protocol for dough preparation was as follows: flour 100 g; water $54.4x10^{-3}$ m^3; cooking salt 1.2 g; yeast 3.5 g; sunflower oil $0.4x10^{-3}$ m^3; crystal sugar 2 g; Na-stearoil-2-lactylat 0.2 g. The level of enrichment with mineral salts is shown in Table 2. The minerals were added into the dough during the kneading process. The parameters of bread making procedure are shown in Table 1. Crusty bread weight yield was 135 g in amounts designated to both of the samples in accord with recommended daily intake (RDI). Laboratory baking tests for obtaining the bread enriched in minerals were done according to modified method used in the Department of technology of cereals, forage, bread and confectionery products, University of Food Technology, Plovdiv (Bulgaria) (Table 1).

3. Sensory evaluation.

Consumer test for acceptance (Resurreccion, 1998; Peryam, DR and Pilgrim PJ., 1957) was performed at the Consumer & Sensory Analyses Lab in the Food Research and Development Institute (FRDI) in Plovdiv, Bulgaria. The enriched bread samples with minerals were baked one day before the test and in the test day were delivered to the sensory lab kitchen where the loaf of breads were sliced to 3 mm thickness, coded with three digit random numbers and presented in a balanced sequential monadic order.

The bread rolls enriched in fibres, obtained in the pilot plant of the institute in Romania, were tasted after 48 hours, due to the transportation reasons from Romania to Bulgaria. They were packed in plastic bags and maintained in a cold and dry place. The three types of rolls were presented to the consumers in their round shape.

Consumers over age of 62 (n=15) were picked up among the ex-employees currently retired from the FRDI with no allergies towards bread, gluten, yeast, minerals, inulin and yogurt and must consume bread at least once a day. Overall 5 samples of enriched bread were evaluated in two consecutive days with two replications (first day – three types of bread with added fibres and second day – three types of bread with minerals). Consumers used 9-point hedonic scale (1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much, and 9 = like extremely), using pens and paper ballots to rate overall acceptance, appearance, odour, texture, flavour and aftertaste, and sweetness and acidity for the samples with fibres.

Table 1: Parameters of bread making procedure

Stages	Time, min	Temperature, °C
Bread rolls improved in soluble fibres		
Dough mixing	10-12 (two speeds)	34.5±0.5
Dough fermentation under controlled conditions	30.0	30.0±0.5
Dough forming in small portions around 140 g	3.0	30.0±0.5
Proofing	50.0	30.0±0.5
Baking	20.0	230
Bread enriched with iron and zinc.		
Dough mixing	6.0 (two speeds)	40.6±0.5
Dough fermentation under controlled conditions	30.0	33.0±0.5
Dough forming in small portions around 150g	3.0	-
Proofing	40.0	37.5±0.5
Baking	20	230

Table 2: Levels of enrichment with minerals

Minerals, salts	RDI, g	E, g/100 g flour
$FeSO_4*7H_2O$	0.012	0.006
$ZnCl_2$	0.010	0.004

E – Level of enrichment corresponding to 10% enrichment level to compliment the daily intake (RDI) (the quantities of salts are calculated in compliance with the real content as ion)

4. Volume test.

The volume of the bread loaves was compared based on photos of half breads.

5. Texture test.

To compare the texture of the breads quasi non-destructive hysteresis tests were performed with Stable Micro Systems TAXT2 instrument equipped by a cylinder (d=25 mm), in uniaxial compression mode up to 35 % strain of the 10 mm slices with slow deformation speed (0.1 mm*s^{-1}).
The degree of elasticity was calculated based on the curves:

$$Degree\ of\ elasticity = \frac{\int_{F_{max}}^{0N} F(D)\cdot d(D)}{\int_{D=0}^{F_{max}} F(D)\cdot d(D)} \qquad (1)$$

6. Physico-chemical analysis of bread rolls enriched in fibres.

The obtained bread rolls enriched in fibres were analysed for their physico-chemical characteristics (in accordance with Romanian standard STAS 91: 2007 for baked products analyses): humidity (%), acidity (grades), lipids (% d.w.), protein content (% d.w.), ash content (% d.w.), data shown in Table. 4.

7. Statistics.

The data were statistically analysed using STATISTICA software (STATISTICA 7, 2005) to determine the means, standard deviation and significant differences between bread samples for each given attribute. T-test was performed to determine which sample means were significantly different (α=0.05).

RESULTS AND DISCUSSION

1. Consumer acceptance test (Table 3).

The mean consumer ratings for appearance, odour, mouthfeel/texture, flavour/taste and aftertaste for all the bread samples, and sweetness and acidity for samples enriched with fibres along with significant differences of the hedonic ratings for the sensory attributes of the bread samples are presented in Table 3. Bread enriched with mineral salts had the highest mean ratings for all attributes evaluated in the consumer acceptance test.

Overall acceptance.

All the mean ratings for overall acceptance were above 6.0 (like slightly), indicating that all of the bread samples were liked by the consumers. Samples D, E and F rated highest in overall acceptance compared to all other samples. Its mean rating was 8.1, 7.8 and 7.8 compared to samples A, B and C which had ratings of 7.5, 6.8 and 6.7, respectively (Figure 3).

Appearance.

The bread sample D (x=8.2) was significantly highest in appearance compared to all other samples while sample C rated significantly lower (x=7.1). Samples A, B, E and F had mean ratings of 7.9, 7.4, 7.8 and 7.9, respectively, were liked moderately. There were no significant differences among the samples A, E and sample B and F was rated significantly lower.

Odour.

The ratings for odour for all the bread samples were similar but sample D was significantly higher (x=7.6) Samples A, B, E and F had mean ratings of 7.3, 7.1, 7.1 and 7.4 respectively, and were liked moderately and sample C was liked slightly (x=6.7). There were no significant differences among the A, B, C, E and F.

Table 3: Means of hedonic ratings of sensory attributes of bread enriched with fibres and minerals

Samples	Appearance	Odour	Mouthfeel/ texture	Flavour/ Taste
A	$7.9^{a}\pm0.74$	$7.3^{a}\pm0.42$	$7.6^{a}\pm0.70$	$7.3^{a}\pm0.82$
B	$7.4^{ab}\pm0.52$	$7.1^{a}\pm1.29$	$7.0^{a}\pm1.15$	$6.5^{a}\pm0.71$
C	$7.1^{b}\pm1.29$	$6.7^{a}\pm1.06$	$7.0^{a}\pm0.33$	$6.6^{a}\pm1.26$
D	$8.2^{ac}\pm0.42$	$7.6^{ab}\pm1.35$	$8.0^{ab}\pm0.67$	$8.1^{b}\pm0.74$
E	$7.8^{a}\pm0.42$	$7.1^{a}\pm1.20$	$7.6^{a}\pm0.70$	$7.4^{a}\pm0.97$
F	$7.9^{a}\pm0.70$	$7.4^{a}\pm0.42$	$7.7^{a}\pm0.70$	$7.5^{a}\pm0.82$

Samples	Aftertaste	Sweetness	Acidity
A	$7.5^{a}\pm0.71$	$7.3^{a}\pm0.67$	$6.5^{b}\pm1.18$
B	$5.7^{c}\pm1.21$	$6.5^{ab}\pm0.43$	$6.0^{b}\pm0.56$
C	$5.8^{c}\pm1.10$	$6.2^{b}\pm0.75$	$6.1^{b}\pm0.60$
D	$7.9^{ab}\pm0.57$	n.a.	n.a.
E	$7.4^{a}\pm1.35$	n.a.	n.a.
F	$7.6^{a}\pm0.71$	n.a.	n.a.

Means in the same column not followed by the same letter are significantly different at p=0.05 as determined by t-paired means test

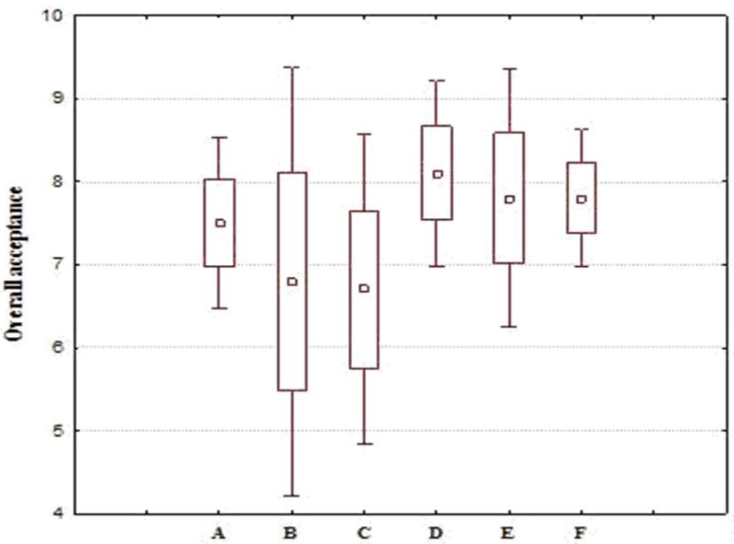

Figure 3

Overall acceptance of breads enriched with fibres and minerals

Mouthfeel/Texture.

All the mean ratings for mouthfeel/texture were rated above 7.0 (like moderately), indicating that all of the bread samples were liked by the consumers. The mouthfeel/texture of the sample D with mean rating of 8.0 was significantly different from the rest of the samples. Samples A, B, C, E and F which had mean ratings of 7.6, 7.0, 7.0, 7.6 and 7.7, respectively, showed no significant difference from one another.

Flavour/Taste.

The flavour of all the bread samples were rated above 6.0 (like slightly), except for samples A, E and F which were rated higher (x=7.3, x=7.4 and x=7.5) (like moderately). Sample D was liked very much (x=8.1) and had a rating significantly higher than the rest of the samples.

Aftertaste.

The aftertaste of all the bread samples were rated above 7.0 (like moderately), except for the samples B and C, which were rated 5.7 and 5.8, respectively (neither liked nor disliked). The Sample D (x=7.9) was significantly higher than the samples A, E and F which had ratings of 7.5, 7.4 and 7.6, respectively.

Sweetness.

The sample A (x=7.3) was significantly highest in sweetness compared to all other samples enriched with fibres. The samples B and C were liked slightly (x=6.5 and 6.2) with no significant differences between them.

Acidity.

All the mean ratings for acidity were rated above 6.0 (like slightly), indicating that all of the bread samples were liked by the consumers. The acidity ratings for all the bread samples enriched with fibres were similar with mean ratings of 6.5, 6.0 and 6.1 and rated not significantly.

2. Volume test.

Based on the comparison between the photos the bread enriched with the mixture of minerals had the biggest volume and the smallest one was for the Zn^{2+} enriched bread. The Fe^{2+} gave a loose structure of the bread which is visible from the bigger porosity of the product. The product enriched with zinc showed a compact structure. The mixture of these minerals gave bread, with moderate structure, and high volume. (Figure 4)

3. Texture tests.

The highest degree of elasticity was shown by the bread enriched with mixture of minerals but with no significant differences with the zinc enriched bread. Iron enriched bread was significantly different by degree of elasticity (Figure 5.).

4. Physico-chemical parameters.

The physico-chemical indices of the bread rolls enriched in fibres shows (Table 4) that the samples had similar humidity but some differences in acidity, lipids, protein and ash content due to the differences in the quality of the flour used for their preparation.

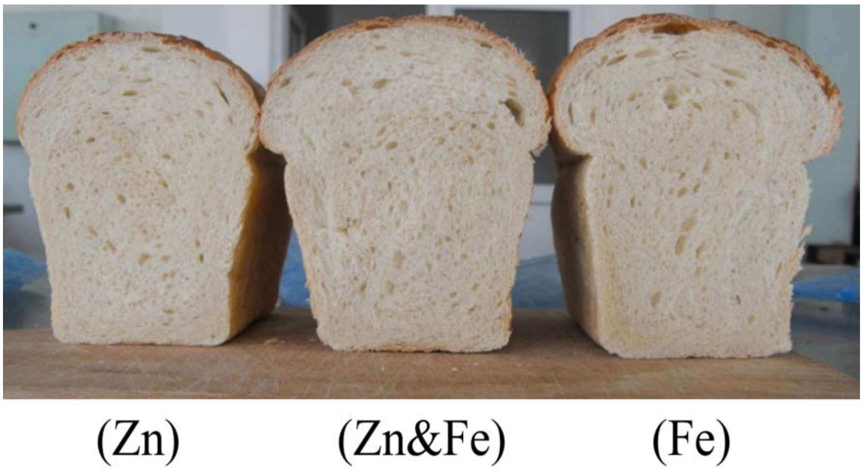

Figure 4
Volume of the loaves of breads enriched with minerals

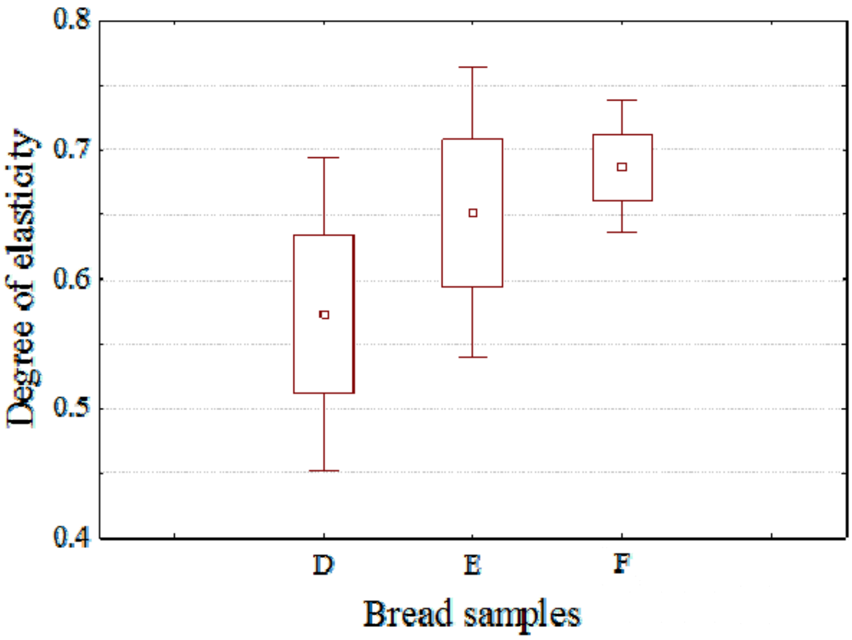

Figure 5
Degree of elasticity of the bread slices enriched with minerals

Table 4: Physico-chemical characteristics of the obtained bread rolls enriched in fibres

Samples	A (White bread rolls)	B (Brown bread rolls)	C (Whole meal bread rolls)
Humidity, %	**45.89**	**42.36**	**42.21**
Acidity, grades	**1.00**	**1.20**	**1.60**
Lipids, % d.w.	**0.79**	**0.86**	**1.05**
Proteins, % d.w.	**12.15**	**14.32**	**16.81**
Ash, % d.w.	**1.20**	**1.52**	**1.71**

CONCLUSIONS

The evaluators appreciated more the samples of bread from white flour enriched in minerals and less the samples in the form of rolls. This can be explained by the fact that samples of bread were sliced and presented to the panellists in slices, while rolls of 100 g were presented as such and evaluators had to break them. analyse them for the outside aspect and then for the inside aspect, also, the rolls had 48 hours from the baking time and the bread with minerals only 24 hours from the baking time.

However, from the three types of rolls, the most appreciated was the sample of rolls from white wheat flour with added inulin, than the rolls from brown wheat flour and the last preferred sample was the roll from whole wheat with added inulin. This demonstrates once again that consumers are more familiar with white flour products and less familiar with whole wheat products.

The consumer panel rated white wheat bread enriched with Fe^{2+} as the best product. White wheat bread treatment enriched with combination of minerals rated second followed closely by Zn^{2+} bread and white wheat bread sample enriched with inulin.

Main differences were observed in appearance and aftertaste for whole wheat bread treatment enriched with inulin and brown wheat bread enriched with inulin.

Whole wheat bread enriched with inulin was the least preferred sample.

Based on the volume and texture experiments the iron loosened the structure of the bread and the zinc strengthened it (made it more compact).

ACKNOWLEDGEMENT

This work was funded by the Joint Research Project Collaboration between Bulgaria (Fund Scientific Research – Bilateral Cooperation with Romania) and Romania (National Program II – Capacities/Bilateral Cooperation in Romania).

REFERENCES

Amita R. Shah, R. K. Shan, Datta Madamwar (2006): Improvement of the quality of whole wheat bread by supplementation of xylanase from Aspergillus foetidus. Bioresource Technology. vol. 97 **(16)**. 2047-2053.

Gariballa.S.E., Sinclair.A.J. (1998): Nutrition, ageing and ill health. British Journal of Nutrition, **80**:7-23.

Jiang. Z. Q., S. Q. Yang, S. S. Tan, L. T. Li, X. T. Li (2005): Characterization of a xylanase from the newly isolated thermophilic Termomyces lanuginosus CAU44 and its application in bread making. Letters of Applied Microbiology, **41**. 69-76.

Kim. Y.Y., Jang. K.H., Lee. E.Y., Cho. Y., Kang. S.A., Ha. W.K., Choue. R. (2004): The effect of chicory fructan fiber on calcium absorption and bone metabolism in Korean postmenopausal women. Nutr. **7**:151-157.

Lanqin Xia, Hongwei Geng, Xinmin Chen, Zhonghu He, Morten Lillemo, Craig F. Morris (2008): Silencing of puroindoline an alters the kernel texture in transgenic bread wheat. Journal of Cereal Science, **47**. 331-338.

Mahmoud Abu-Ghoush, Thomas J Herald, Floyd Dowell, Feng Xie. Fadi M Aramouni, Ronald Madl (2008): Effect of preservatives addition on the shelf-life extension and quality of flat bread as determined by near-infrared spectroscopy and texture analysis. International Journal of Food Science and Technology, **43**. 357-364.

Marteau P., Jacobs H. Cazaubiel M., Signoret C., Prevel JM., Housez B. (2011): Effects of chicory inulin in constipated elderly people: a double-blind controlled trial. Int J Food Sci Nutr., **62**:164-70.

Meyer. D. de Wolf. J. (2008): Inulin in bread and other cereal-based products. in: Technology of functional cereal products, ed. Bruce R. HamakerCRC press, Anglia.

Nyuk L Chin, Grant M Campbell (2005): Dough aeration and rheology: Part 1. Effects of mixing speed and headspace pressure on mechanical development of bread dough. Journal of the Science of Food and Agriculture, **85**. 2184-2193.

Peryam, DR and Pilgrim PJ. (1957): Hedonic scale method for measuring food preferences. Food Technology, **11:** 9-14.

Physiological norms of nutrition for the Bulgarian population (2001): Regulation № 23/17.05.2001 about the conditions and requirements for the nutritional information presented on the food labels. State gazette, 53.

Resurrection, A. V. A. (1998): Consumer Sensory Testing for Product Development. Aspen Publications Inc. Gaithersburg. MD.

StatSoft Inc. (2005). STATISTICA®: The Small Book. Tulsa. OK.