POLISH JOURNAL OF FOOD AND NUTRITION SCIENCES

www.pan.olsztyn.pl/journal/
e-mail: joan@pan.olsztyn.pl

Pol. J. Food Nutr. Sci.
2008, Vol. 58, No. 1, pp. 113-117

POSSIBILITY OF PARTIAL REPLACEMENT OF FAT BY INULINE IN COOKIES IN ORDER TO DECREASE THEIR CALORIC VALUE

Anna Żbikowska[1], Jarosława Rutkowska[2]

[1]Faculty of Food Technology, [2]Faculty of Human Nutrition and Consumer Sciences, Warsaw University of Life Sciences

Key words: inuline, cookies, sensory properties, texture, trans fatty acids

Effects of inuline used as partial fat replacement in cookies containing three different fats were studied. During experiment sensory and instrumental attributes of reference cookies and low fat formulation in which 50% of fat was replaced with inuline were compared. Shortenings used for preparation of cookies differed greatly in saturated fatty acids (SFA) (29.9–57.5%), trans fatty acids (TFA) (0.9–23.1%) and solid fat content (SFC) at 25°C (13.6–31.6%). Replacement of 50% fat with inuline in the formulations enabled obtaining samples with higher instrumental values of texture and resulted in cookies which were harder and less crispy. Also the intensity of sweet taste was sharply reduced by decreasing the fat content of cookie recipes. On the other hand, replacement of 50% of fat with inuline had a little impact on the intensity of buttery taste of the cookies. The lowest intensity of buttery taste was scored in cookies containing shortening with the lowest content of TFA. Concerning the overall sensory quality, the results showed that the replacement of 50% of fat with inuline resulted only in a moderate decrease in the acceptability of the overall sensory quality. The averaged scores of overall sensory quality were generally high and ranged from 7.1 to 9.1. In conclusion, it has been demonstrated that inuline was suitable for inclusion in cookies, as a fat replacer and as a functional ingredient.

INTRODUCTION

Many cookies and other sweet baked goods contain high amounts of sugar and fat. From the point of view of nutritive properties, excessive consumption of bakery products is not recommended for it is linked with the intake of SFA and TFA [Balas, 2001; Erp-Baart *et al*., 1998; Daniewski, 1998] which are known to provoke an increase of LDL/HDL-cholesterol ratio, with a consequent increase in the risk of cardiovascular diseases [Mensik *et al*., 2003; Juttelstad, 2004].

The consumption of sweet bakery products in Poland amounted nearly 8 kg/person/year (2002-2006 years) and evidence suggests that this will remain stable, because these products are important dietary components of mid-morning and afternoon snacks and also their sweetness and marked palatability are elements which promote their consumption [Gouveia *et al*.2007].

Inuline is a storage polymer composed of β-2,1-linked fructosyl moieties mostly with a terminal glucosyl residue. It occurs in many plants such as in banana, wheat, onions and chicory [Van Loo *et al*., 1995]. Inuline content ranges from less than 1% in banana to more than 15% in chicory roots with the number of fructosyl residues (degree of polymerisation, DP) extending from 3 to 250, depending on the plant species and the plants' life cycle [Kip *et al*., 2005].

For about 20 years, inuline has also been available as an ingredient for application in the food industry, where it is used in a large variety of food products, both for their technological and nutritional benefits. Its nutritional benefits arise from the fact that inuline is a dietary fibre [Flamm *at al.,* 2001] and consequently has a low caloric value and that it resists gastric acid and digestion in the human small intestine [Roberfroid, 1999]. Consumption of inulins also leads to an increase in the number of *Bifidobacterium* and *Lactobacillus* species in the human fecal colon microbiota [Gibson *et al*., 1995]. Based on a combinations of these properties inuline finds applications in, for instance, dairy products, beverages, spreads, ice cream, confectionery, bread and other bakery products.

The aim of this study was to examine the effect of partial replacement of some fats with inuline in cookies on their sensory and instrumental quality indices.

MATERIALS AND METHODS

MATERIALS

Experimental cookies were prepared using a recipe containing high amount of fat (55% with respect to flour). It is a typical formula of short-dough biscuits mostly used in manufacturing cookies in Poland. Three different shortenings were used for the preparation of reference cookies: Akobake K, Akobake P (Karshamns, Sveden) and Cargill shortening (Cargill, the Netherlands). All are based on fractions of palm oil. In low fat formulation 50% of fat was replaced with inuline.

Author's address for correspondence: Jarosława Rutkowska. Department of Food Analysis, Quality Assessment, Warsaw University of Life Sciences, ul. Nowoursynowska 159 C, 02-776 Warszawa, Poland; tel./fax: (48 22) 59 37 071; e-mail: jaroslawa_rutkowska@sggw.pl

Ingredients for preparing cookies

The reference cookie formulation contained the following ingredients: 240 g of wheat flour, 133 g of fat, 90 g of powdered sugar, 76 g of egg yolks, 10 g of dried milk. In low fat formulation 50% fat was replaced with 17 g inuline (Hortinex). This corresponds to Hortinex recommendations according to which 1 g of inuline replaces 4 g of fat.

Preparation of cookies

All ingredients were blended in a Philips mixer for 6 min. Inuline was added directly to the blended fat and mixed with other ingredients. Thereafter, the mixed dough was rolled out and cut in square pieces 55 mm in length and 4 mm in thickness. The cookies were placed into baking cups and baked at 190°C for 12 min in a Sveba Dahlin Fristad Sveden oven. The prepared cookies were subjected to instrumental and sensory analysis 24 h after baking.

METHODS

Analysis of fats

Gas chromatography (GC) was used to determine FA composition of the investigated fats according to the Polish Standard [PN-EN ISO 5508:2000]. Methyl esters were prepared according the Polish Standard [PN-ISO 5509:2000]. The composition of FA was expressed as the peak area percentage of total FA. Instrument: HP 6890 GC System with autosampler; SGE Capillary BPX 70, column: 60 m x 0.25 mm ID; oven: temperature program from 160 to 210°C, rate: 2.5°C/min; carrier gas: helium, air: 300 mL/min; injector: Split-Splitless 240°C; detector: FID 250°C; software: HP Chemstation v. 3.11. Method validation was carried out with a reference sample CRM-163 EEC-EAEC (Brussels, 1993). SFC of fats was determined by means of pulsed nuclear magnetic resonance spectroscopy using NMS 120 Minispec NMR Analyzer Bruker instrument at 25°C. Melting point (MP) was estimated with the capillary method following the Polish Standard [PN-EN ISO 6321:2004]. According to the standards, analyses of fats were conducted in two replications.

Sensory evaluation of cookies

Sensory analysis of cookies was carried out using the scaling method by a sensory panel according to Polish Standard [PN ISO 4121:1998]. The sensory panel of ten members, habitual consumers of bakery products (students and faculty staff members: 24–46 years of age), made each evaluation in duplicate. They scored all sensory attributes on a 100 mm unstructured scale and converted the scores after collection into 0-10 conventional units scale. They were asked to taste each cookie and rated intensity of buttery aroma, sweet taste and buttery taste of each sample. The scales were anchored at each extreme with "not at all …." and "extremely ….". The subjects rated acceptability of appearance and attributes of cookies texture: hardness, crispness and greasiness and overall quality. The scales were anchored at extreme "low…" and "high…". Only with respect to the greasiness the scales were anchored at extreme "not at all …" and "extremely …". measured using a linear scale. Samples of cookies were coded and given to each assessor in individual random order.

Instrumental analysis of cookies

Texture measurements were carried out using Texturometr Model TA-XT2 (Stable Micro Systems, UK) by a bending--snapping test according to Baltsavias *et al.* [1999]. Procedure: broken shear force of each cake was determined as an indication of hardness and crispness. A 10 kg load cell was used and crosshead speed set at 1 mm/min, temperature 23°C. Volume of cookies (in cm^3) was determined using Jakubczyk & Haber method [1983].

Data were analysed with the use of Statgraphics plus 4.1. Duncan' s test was used to assess the differences between means at $p<0.05$.

RESULTS AND DISCUSSION

Fats

The results of GC analysis of fats are presented in Table 1. Shortenings differed in the content of SFA which ranged from 29.9 to 57.5%. Generally, the levels of SFA in all used fats were high, which is typical of bakery fats because SFA are resistant to oxidation and on the whole have excellent technological properties [Krygier & Żbikowska, 2002]. Shortenings differed greatly in TFA content which are regarded as especially undesirable in the diet [Pedresen, 2001]. However, TFA have an excellent effect on the structure of bakery products. Many studies revealed that bakery and confectionery fats are the crucial sources of TFA [Balas, 2001; Daniewski *et al*., 1998; Erp-Baart *et al*., 1998; Parcerisa *et al*., 1999].

From the three shortenings studied Cargill fat was characterised by both the lowest content of TFA (0.9%) and the highest content of SFA (57.5%). As expected, the studied fats contained low amount of polyunsaturated FA (PUFA) (5.9 to 0.5%) (Table 1). Unsaturated FA are undesirable in bakery fats because they are not resistant to environmental stress during the baking process (high temperature). At high temperature unsaturated FA, especially α-linolenic acid (C 18:3) are the main source of undesirable oxidation products.

There were no significant differences in MP between shortenings. In contrast, fats differed in SFC content (13.6-31.6%), (Table 1).

Sensory and instrumental evaluation of cookies

Flavour, texture and appearance are the main quality attributes of cookies. Fat is a very important ingredient of cookies because it contributes to the texture and pleasing mouthfeel and additionally positively impacts flavour intensity and perception [Zoulias *et al.,* 2002]. Sensory intensity of aroma,

TABLE 1. Characteristics of the examined fats.

Parameter	Brand of fat		
	Akobake K	Akobake P	Cargill
SFA (%)	29.9±0.89	49.1±4.23	57.5±4.10
TFA (%)	23.1±0.90	3.2±0.10	0.9±0.21
PUFA (%)	2.3±0.30	5.9±0.71	0.5±0.20
Sum of *cis* isomers (%)	53.0±3.89	52.3±3.85	56.4±4.12
SFC at 25°C (%)	13.6±0.85	18.2±0.92	31.6±0.91
SMP (°C)	34.6±0.92	35.8±0.98	35.5±0.93

TABLE 2. Results of sensory evaluation of cookies (scale 0-10).

Sample	Intensity			Appearance accept-ability	Overall quality
	Buttery aroma	Sweet taste	Buttery taste		
Akobake K	2.7^{b}	5.1^{b}	4.1^{d}	6.6^{bc}	9.1^{c}
Akobake K + inuline	2.1^{b}	3.6^{a}	3.6^{cd}	6.8^{c}	7.8^{b}
Akobake P	2.5^{b}	5.7^{c}	3.5^{bcd}	5.1^{a}	8.1^{b}
Akobake P + inuline	2.0^{a}	4.6^{b}	3.4^{bc}	6.2^{b}	8.1^{b}
Cargill	1.8^{a}	5.3^{bc}	2.8^{ab}	7.3^{d}	8.9^{c}
Cargill + inuline	1.2^{a}	3.7^{a}	2.5^{a}	6.7^{c}	7.1^{a}
NIR	0.81	0.79	0.69	0.74	0.50

The same letters denote non-significant differences ($p<0.05$) between mean values in the same column.

TABLE 3. Results of sensory assessment of texture attributes of cookies (scale 0-10).

Samples	Attributes of texture		
	Hardness	Crispness	Greasiness
Akobake K	5.3^{b}	5.7^{b}	3.4^{a}
Akobake K + inuline	8.3^{d}	3.1^{a}	5.6^{b}
Akobake P	3.9^{a}	6.8^{c}	3.9^{a}
Akobake P + inuline	8.2^{cd}	2.9^{a}	5.5^{b}
Cargill	4.0^{a}	7.5^{c}	5.5^{b}
Cargill + inuline	7.6^{c}	3.3^{a}	6.1^{b}
NIR	0.78	0.83	0.85

The same letters denote non-significant differences ($p<0.05$) between mean values in the same column.

intensity of taste, acceptability of appearance and overall ratings averaged over the six types of cookies are presented in Table 2. The statistical comparison was made between the control cookies containing three different fats and the three with the lower fat content containing inuline.

The lowest intensity of buttery aroma was rated in cookies containing shortening with 57.5% SFA and 0.9% TFA (Cargill) for both inuline-containing and control recipes. Replacement 50% of fat with inuline had significant ($p<0.05$) impact on the intensity of buttery aroma of cookies containing shortening with 49% SFA and 3.2% TFA (Akobake P) (from 2.5 to 2.0). In the case of Akobake K or Cargill shortenings, the effect of fat replacement with inuline was not statistically significant ($p<0.05$). Generally, the sensory panel found low intensity of buttery aroma in all samples.

Appearance and taste are highly relevant to the consumer preference of foods and are particularly important, in the case of health-promoting foods, in those groups most inclined to unhealthy diets [Neumark-Sztainer *et al.,* 1999]. This conclusion may be extrapolated to functional foods and therefore, in our study, an assessment has been made of sensory intensity in sweet and buttery taste in control cookies and cookies with 50% of fat replaced with inuline. The intensity of sweet taste was sharply reduced by reducing the fat content of cookie recipes (Table 2). It was particularly evident when shortening with the lowest TFA content (0.9%) was utilized (decreasing intensity of sweetness of cookies from 5.3 to 3.7 was attained). Similar results were presented by Drewnowski *et al.* [1998] in cookies with 25% reduced sugar content and confirmed that the key sensory attribute for this class of food products is sweetness and that consumers are very sensitive to any variations in sugar content.

Replacement of 50% of fat with inuline had a little impact on the decreasing intensity of buttery taste of cookies. The lowest intensity of buttery taste was scored in cookies containing shortening Cargill (with the lowest content TFA).

With respect to using shortening Akobake K, the sensory panel did not find differences ($p<0.05$) in the appearance between control cookies and those containing inuline. Replacement of 50% of Cargill with inuline significantly ($p<0.05$) decreased the scoring of appearance, whereas the cookies containing inuline with shortening Akobake P attained higher scores with respect to acceptability of appearance than the control samples (5.1 and 6.2, respectively).

With respect to cookies containing Akobake K and Cargill, the estimation of overall sensory quality (Table 2) confirmed lower acceptability of cookies in the case when 50% of fat was replaced with inuline. With respect to Akobake P no significant differences were found between control cookies and those containing inuline. Generally, the averaged scores were high and ranged from 7.1 to 9.1 (on the scale 0-10 cm).

Texture of cookies

The importance of cookies texture in consumer acceptance is increasingly recognized. Fat is one of the principal ingredients that affect cookies texture. Substitution of fat with other ingredients had a greater impact on textural attributes of cookies than the replacement of sugar or flour [Campbell *et al*., 1994]. It can be seen (Table 3) that reducing the fat content by 50% and replacing it with inuline in cookie recipes led to higher ratings of hardness. The same results were obtained during instrumental measurement of texture (Table 4).

In all samples replacement of fat with inuline resulted in 2-fold increase of instrumental values of texture. For example,

TABLE 4. Results of instrumental measurements of physical properties of cookies.

Physical property	Sample					
	Akobake K	Akobake K + inuline	Akobake P	Akobake P + inuline	Cargill	Cargill + inuline
Volume (cm^3) NIR = 1.05	30.1^{b}	28.9^{a}	33.3^{d}	31.6^{c}	35.5^{e}	30.4^{b}
Texture (N) NIR = 3.18	15.6^{a}	37.4^{d}	14.0^{a}	39.9^{d}	12.6^{a}	29.8^{c}

The same letters denote non-significant differences ($p<0.05$) between mean values in the same line.

instrumental texture of cookies containing shortening Akobake K was 15.6 N and after replacement of 50% of fat with inuline it increased to 37.4 N. In several studies it is pointed that high values of shear force (which indicated hardness) is an unpleasant attribute for such type of product [Zoulias *et al*., 2002; Rutkowska, 2003].

Crispness can be considered as a pleasant sensory property of cookies as far as it does not become extremely great [Zoulias *et al.,* 2002]. Sensory panel found reference cookies crispy (5.7–7.5 points), which was strongly reduced after replacing 50% fat with inuline (2.9–3.3 points).

Decrease in crispness was associated with higher hardness. The above results obtained are similar to those described in the literature. For example, Maache-Rezzoug *et al.* [1998] investigated the effect of fat content on biscuit texture and found that an increase in fat content in biscuits resulted in more friable and crispy products. Reduction of fat in cookies resulted in a chewy texture and decreasing moisture content [Sanchez *et al.,* 1995]. Greasiness is a texture attribute of cookies perceived during mastication. For cookies containing shortenings Akobake K or Akobake P replacement of 50% of fat with inuline significantly increased the scoring of greasiness. In the studies on the texture of crackers Martinez *et al.* [2002] found that high intensity of greasiness was not acceptable by consumers.

Instrumental estimation of the volume of cookies revealed decreasing values as a result of replacing 50% fat with inuline. The differences in volume between two types of cookies studied did not exceed 15%. During evaluation of the acceptability of appearance the analytical panel highly scored the lower volume of cookies containing inuline (from 6.2 to 6.7 scores).

CONCLUSIONS

Reduction of fat in the formulations led to samples with higher instrumental values of texture, therefore resulted in cookies which were estimated as more hard.

On the other hand, the replacement of 50% of fat with inuline had various effects on the sensory properties of the samples depending on the shortening used:

• Intensity of sweet taste was significantly reduced by decreasing the fat content of cookie recipes. It was particularly evident when shortening with the lowest TFA content (0.9% Cargill) was utilized.

• Replacement of 50% of fat with inuline had a significant impact on intensity of buttery aroma of cookies containing shortening with 49% SFA and 3.2% TFA (Akobake P). Generally, the sensory panel found low intensity of buttery aroma of all samples.

• Replacement of 50% of fat with inuline had a little impact on the intensity of buttery taste of cookies. The lowest intensity of buttery taste was scored in cookies containing shortening with the lowest content of TFA.

• The replacement of 50% of fat with inuline resulted only in a moderate decrease of the acceptability of overall sensory quality.

These data have some implications for designing acceptable lower-energy cookies. Sweetness is a desirable sensory attribute in this group of food products. As a result, any manipulations that reduce the sweetness level of cookies will result in their diminished acceptance. On the other hand, reducing the fat content in cookies will decrease the total and fat calories, and replacing part of fat with inuline will influence the nutritional benefits.

REFERENCES

1. Balas J., Fatty acids in commercial food products. Part I. Safe Food, 2001, 1, 20-21 (in Polish).
2. Baltsavias A., Jurgens A., Van Vliet T., Properties of short dough biscuits in relation to structure. J. Cereal Sci., 1999, 29, 3, 245-255.
3. Campbell L., Ketelsen S.M., Antenucci R.N., Formulating oatmeal cookies with calorie-sparing ingredients. Food Technol., 1994, 48, 98-105.
4. Daniewski M., Mielniczuk E., Jacórzyński B., Pawlicka M., Balas J., Fatty acids, in particular trans isomers content in food products. Żyw. Człow. Metab., 1998, 2, 133-148 (in Polish; English abstract).
5. Drewnowski A., Nordensten K., Wyder J., Replacing sugar and fat in cookies: Impact on product quality and preference. Food Qual. Pref., 1998, 91/2, 13-20.
6. Erp-Baart M.A., Couet C., Cuadrado C., Kafatos A., Stanley J., Poppel G., *Trans* fatty acids in bakery products from 14 European countries. J. Food Comp. Anal., 1998, 11, 161-169.
7. Flamm G., Glinsman W., Kritchevsky D., Prosky L., Roberfroid M., Inuline and oligofructose as dietary fiber: A review of the evidence. Crit. Rev. Food Sci. Nutr., 2001, 41, 353-362.
8. Gibson G.R., Beatty E.R., Wang X., Cumnnings J.H., Selective stimulation of bifidobacteria in the human colon by oligofructose and inuline. Gastroenterology, 1995, 108, 975-982.
9. Gouveia L., Batista A.P., Miranda A., Empis J., Raymundo A., *Chlorella vulgaris* biomass used as colouring source in traditional butter cookies. Innov. Food Sci. Emerg. Technol., 2007, 8, 433-436.
10. GUS Household Budżet Data, 2002-2006, GUS, Warsaw.
11. Jakubczyk T., Haber T., Analiza zbóż i przetworów zbożowych. 1983, Wyd. SGGW Warszawa, pp. 286-289 (in Polish).
12. Juttelstad A., The marketing of trans fat-free foods. Food Technol., 2004, 1, 20.
13. Kip P., Meyer D., Lellema R.H., Inulins improve sensoric and textural properties of low-fat yoghurts. Int. Dairy J., 2005, 16, 1098-1103.
14. Krygier K, Żbikowska A., Influence of fat on some factors of sponge cakes. Żywność Nauka Technologia Jakość, 2002, 3, 47-57 (in Polish; English abstract).
15. Maache-Rezzoug, Z., Bouvier J.M., Allan K. Patras C., Effect of principal ingredients on rheological behavior of biscuit dough and on quality of biscuits. J. Food Eng., 1998, 35, 23-42.
16. Martinez C., Santa Cruz M.J., Hough G., Vega M.J., Preference mapping of cracker type biscuits. Food Qual. Pref., 2002, 13, 535-544.
17. Mensik R.P., Zock P.L., Kester A.D., Katan M.B., Effects of dietary fatty acids and corbohydrates on the ratio of serum total to HDL cholesterol and on serum lipids and apolipoproteins: a meta-analysis of 60 controlled trials. Am. J. Clin. Nutr., 2003, 77, 1146-1155.

18. Neumark-Sztainer D., Story M., Perry C., Casey M.A., Factors influencing food choices of adolescents: findings from focus group discussions with adolescents. J. Am. Diet. Assoc., 1999, 99, 929-937.
19. Parcerisa J., Codony R., Boatella J., Rafecas M., Fatty acids including trans content of commercial bakery products manufactured in Spain. J. Agri. Food Chem., 1999, 47, 2040.
20. Pedersen J.I., More on trans fatty acids. Brit. J. Nutr., 2001, 85, 249-250
21. Polish Standard PN-EN ISO 5508:2000. Animal and vegetable fats and oils – Analysis by gas chromatography of methyl esters of fatty acids (in Polish).
22. Polish Standard PN-ISO 5509:2000. Animal and vegetable fats and oils- Preparation of methyl esters of fatty acids (in Polish).
23. Polish Standard PN-EN ISO 6321:2004. Animal and vegetable fats and oils. The determination of melting point in open capillary tubes (slip point), (in Polish).
24. Polish Standard PN-ISO 4121:1998. Sensory analysis – Methodology – Evaluation of food products by methods using scales (in Polish).
25. Roberfroid M.B., Caloric value of inuline and oligofructose. J. Nutr., 1999, 129, 1436-1437.
26. Rutkowska J., Studies on the functional properties of bakery margarines. 2003, *in:* Culinary Arts and Sciences IV Global and National Perspectives (ed. J.S.A. Edwards, I.B., Gustafsson). Bournemouth University, UK, pp. 208-219.
27. Sanchez C., Klopfenstein C., Walker C.E., Use of carbohydrate--based fat substitutes and emulsifying agents in reduced-fat shortbread cookies. Cereal Chem., 1995, 72, 25-29.
28. Van Loo J.A.E., Coussement P., De Leenheer L., Hoebregs H., Smits G., On the presence of inuline and oligofructose as natural ingredients in the Western diet. Crit. Rev. Food Sci. Nutr., 1995, 35, 525-552.
29. Zoulias E.I., Oreopoulou V., Tzia, C., Textural properties of low--fat cookies containing carbohydrate- or protein-based fat replacers. J. Food Eng., 2002, 55, 337-342.

Received March 2007. Revision received September and accepted October 2007.

MOŻLIWOŚCI ZASTĄPIENIA INULINĄ CZĘŚCI TŁUSZCZU W CIASTKACH W CELU OBNIŻENIA ICH WARTOŚCI KALORYCZNEJ

Anna Żbikowska[1], Jarosława Rutkowska[2]

[1]Katedra Technologii Żywności, [2]Zakład Analizy i Oceny Jakości Żywności, Szkoła Główna Gospodarstwa Wiejskiego w Warszawie

Celem pracy było określenie możliwości zastąpienia inuliną części tłuszczu w ciastkach kruchych z dodatkiem trzech różnych tłuszczów. Porównano sensoryczne i instrumentalne wyróżniki jakości ciastek, w których 50% tłuszczu zastąpiono inuliną z próbami kontrolnymi. Szorteningi użyte do wypieku eksperymentalnych ciast różniły się zawartością SFA (29,9–57,5), TFA (0,9–23,1%) oraz SFC w 25°C (13,6–31,6%). Zastąpienie w recepturze 50% tłuszczu inuliną powodowało wzrost wartości siły łamania ciastek mierzonej instrumentalnie co było postrzegane w ocenie sensorycznej jako wzrost twardości i spadek kruchości produktów (tab. 3, 4). Podobnie obniżenie tłuszczu w recepturze wyraźnie spowodowało spadek intensywności smaku słodkiego. Z drugiej strony, zastąpienie w ciastkach połowy tłuszczu inuliną w niewielkim stopniu wpływało na sensoryczną ocenę intensywności maślanego smaku (tab. 2). Najniższą intensywność smaku maślanego stwierdzono w wyrobach zawierających tłuszcz z najmniejszą zawartością TFA (0,9%). Również sensoryczna jakość ogólna ciastek wykazała tylko umiarkowany spadek tego wyróżnika gdy 50% tłuszczu zastąpiono dodatkiem inuliny. Średnie wartości ogólnego wyróżnika jakości sensorycznej były wysokie i wynosiły od 7,1 do 9,1 punktów (tab. 2). Uzyskane wyniki potwierdziły informacje z piśmiennictwa o tym, że inulina może być zastosowana w ciastkach zarówno jako dodatek obniżający ich wartość energetyczną jak i dodatek funkcjonalny.