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Magdalena Skotnicka[1], Filip Kłobukowski[2], Maria Śmiechowska[3]
[1,2] Medical University of Gdansk
[3] Gdynia Maritime University

Prospects for Development of Highly Satiating Foods in Poland

Abstract. The high level of competition between food products on the market has encouraged the development of various types of functional foods. Consumer demands and requirements for both medicinal and healthy products has caused food manufacturers to widen their product offerings. The objective of this study was to present the legal status of functional food production and sales, as well as analyse the possibilities of developing customized foods, in particular, highly satiating foods. In this time of obesity epidemic, the use of specifically designed food products which suppress hunger and give the feeling of satiety could be an effective tool in preventing obesity and controlling body mass. There is an optimistic prognoses that this type of food will be introduced on the Polish market.

Key words: functional food, highly satiating food, obesity, Poland

JEL Classification: I12, M31, M37, O33

Introduction

Demand for different types of food has increased with population growth and the development of civilization. More and more, food is seen not only as a source of essential elements, but also as playing a role in promoting health. Among the wide range of products available on the Polish market, a high level of competition has triggered a dynamic development of organic functional and diet food (Szołtysek, Dziuba, 2006). It was not only competition but also the need and the search for high quality food, as a form of protest against industrial food, which resulted in the growth of the food products market. The development of food intended for different groups of people, so called "customized food," is observed in Poland more and more often. The interest in health, nutritional education, higher social awareness, and therefore, particularly specified expectations of consumers, has pushed food manufacturers to introduce functional food into the range of products that they offer.

The definition of designed functional food has not been unified. According to FUFOSE (1991), a product may be considered as functional if it is proved to be beneficial to one or more body functions, beyond the nutritional effect resulting from its traditional chemical composition.

- Functional food may be considered as functional if it is proved to be beneficial to one or more body functions, beyond its nutritional effect, by improving health conditions or reducing the risk of disease.

[1] PhD, Department of Food Commodity Science, Medical University of Gdansk, Dębinki 7, 80-211 Gdańsk, e-mail: skotnicka@gumed.edu.pl
[2] MSc., Department of Food Commodity Science, Medical University of Gdansk, Dębinki 7, 80-211 Gdańsk, e-mail: fklobukowski@gmail.com
[3] Professor, PhD, Department of Commodity Science and Quality Management, Gdynia Maritime University, Morska 81-87, 81-225 Gdynia, e-mail: smiemari@am.gdynia

- The form of functional food must resemble the form of traditional food.
- The higher health quality of functional food is mainly associated with the presence of bio-active substances, stimulating the desired process of metabolism.
- The designed food is intended for general consumption as a part of a daily diet.
- The beneficial effect of functional food should be documented scientifically, by clinical research on human subjects.
- Only scientifically documented benefits allow for recognizing the product as having health promoting properties (Martirosyan and Singh, 2015).

The definition has been constantly modified and discussed. However, it does not impede the development of functional food on the global markets. Its dynamic development is also observed in Poland. Poland is the innovation leader on the food markets of Eastern Europe. This is a good prognosis for all manufacturers who would like to extend their product offerings with innovative, therapeutic and health promoting products.

Legal Regulations Regarding the Sale of Functional Food

The issues regarding the production and distribution of food are regulated by food laws, in particular by the Act of Food Safety and Nutrition of 25th August 2006. In Poland, they are regulated by the said Act of 2016 and in the European Union by Regulation (EC) No. 178/2002 of the European Parliament and of the Council of 28th January 2002 on the general principles and requirements of food law, establishing the European Food Safety Authority and on the procedures in matters of food safety (with later amendments) Official Journal EU L31/1 of 01.02.2002. However, the Act concerns only conventional food. At this moment, there are no legal regulations concerning functional food in detail. Currently, in the countries of the European Union, food is classified as follows: conventional food, modified food, food intended for particular nutritional uses and medical food. All new types of food are determined as novel foods.

The wide range of products and the possibility of the application of designed food in various areas make it difficult to define it, and weakens the chances of establishing a unified principle. Some products considered as functional food are based on the following regulations:

1.) Regulation No. 2015/2283 of 25th November 2015 on novel foods. This Regulation becomes effective on 1st January 2018. According to the regulation, novel foods are subject to characteristic assessment of safety procedures and approval for sale. Under this Regulation, the Commission authorizes and includes a novel food in the EU list if it complies with the following conditions:

- the food does not, on the basis of the available scientific evidence, pose a safety risk to human health;
- the intended use does not mislead the consumers, especially when the food is intended to replace another food, and there is a significant change in the nutritional value;
- where the food is intended to replace another food, it does not differ from that food in such a way that its normal consumption would be nutritionally disadvantageous for the consumer.

2.) The Regulation of the Ministry of Health of 16th September 2010 on fortified food, determining the foodstuffs to which vitamins and minerals are added on compulsory basis.
3.) The Regulation of the Ministry of Agriculture and Rural Development of 10th July 2007 regulating the principles of food labelling.

Other functional food is introduced on the market in compliance with nutrition and health claims, regulated by Regulation (EC) 107/2008, replacing (EC) No. 1924/2006 on nutrition and health claims made on food with regard to executive authority granted to the Commission.

1. Nutrition claims - pursuant to Regulation No. 1924/2006, Art. 2, Par. 2, Point 4) - means any claim which states, suggests or implies that a food has particular beneficial nutritional properties due to the energy or nutrients:

- it contains (e.g. includes vitamin C, source of potassium),
- it contains, in an increased or decreased amount (e.g. high content of protein, of increased content of calcium),
- it does not contain (e.g. it does not include sodium, it does not include sugar).

An entrepreneur may use only these nutrition claims described in the Annex to the Regulation No. 1924/2006, if the product fulfils the conditions stated in the Annex.

2. Health claims - are issued in pursuance with the Annex to the Commission Regulation (EU) No. 432/2012 of 16th May 2012 establishing the list of permitted health claims made on foods, other than those referring to the reduction of disease risk and to children's development and health. On 23rd October 2013 some of the entries of the regulation were amended and Regulation No. 1018/2013 is currently in force. The Regulation describes in detail the approved claims and determines the conditions and limitations of application (Berry Ottaway and Jennings, 2011; Martirosyan and Singh, 2015).

Regulations regarding production, sale and distribution are not globally standardized. The definitions of world leading food manufacturers – Japan, the United States and Europe – are not standardized, which results in numerous global consequences. The lack of a standard definition for countries has led to health claims which have not been governed by any regulations. Even though functional food generates billions of dollars in profits all over the world, the lack of a standard definition hinders the action of scientists, researchers and food manufactures, remarkably affecting the possibility of supplying the food to people with chronic diseases (Berry Ottaway and Jennings, 2011).

Functional food should develop based on the needs and expectations of consumers. The designing of the final product must be connected with various areas of market interest. Scientific research into bio-active ingredients and their potential properties enables the development of health-promoting foods. The results of clinical research direct food technologists and manufacturers to design foods which have beneficial effects for the human body. Manufacturers are obliged to design food products with special health properties as well as food of appropriate nutritional value, physical properties and desired sensory features. Moreover, "novel food" must be safe. Food safety is a global interest, in the view of public health as well as international trade and the exchange of goods. The manufacturers of innovative food should consider the provisions regarding food quality and safety as one of the foundations of production, by using appropriate health and nutrition claims and providing HACCP system-based manufacturing processes (Sztajerska, 2015).

In Poland, the primary scientific assessment is provided by the Chief Sanitary Inspectorate. The assessment includes the analysis of any potential risk resulting from the

introduction of a novel food on the market. The assessment is based on the specification submitted by an applicant, including the results of production, experience, the characteristics of the recipients, and nutritional, toxicological and microbiological information. The Chief Sanitary Inspectorate decides whether an additional assessment will be required (Lipińska, 2015).

Due to the diversity of novel foods and new food ingredients, safety assessments are based on individual case studies (*case by case*), to allow for the adjustment of a given product (Sokołowski, 2014). If the Commission and other member countries do not object to the assessment, and at the same time, an additional assessment is not required, the applicant may introduce the product on the market.

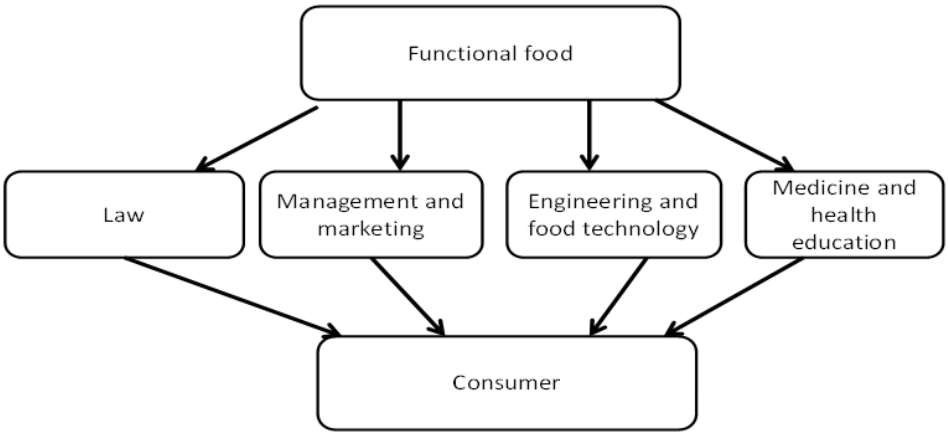

Fig. 1. The areas of interest in various fields influencing the development of functional foods, (authors' own elaboration)

Source: own elaboration.

Functional food combines numerous areas of interest in various fields. Apart from the legal provisions regulating the introduction of products on the market, the engineering and technology of production of functional foods are of primary importance. The design of innovative food products must meet the demands of the market. The requirements include modern production technologies, providing food safety and the use of innovative active packaging. It is essential to make use of the knowledge of scientists and medical doctors. Only combining these elements may result in the production of interesting products which meet the expectations of consumers. This will not be possible without efficient product management and marketing.

The Development of Functional Foods Around the World

In highly developed countries functional food is represented by numerous commonly available products which meet various expectations of consumers. The functional food market is the fastest growing branch of the food industry. Huge food corporations cooperating with the pharmaceutical industry and scientific centers have been preparing

global strategies and launching products on the world markets. Japan is the leader in functional food production. Most often, they offer food preventing dental caries, cardiovascular system disease, obesity and foods that slow down the ageing processes (Tomaszewska et al., 2014).

The production profile of food for special purposes in the United States is oriented on the diseases related to obesity and the complications related thereto. In addition, food dedicated to sportsmen has been developing dynamically, taking into account different sport disciplines and the type of exercise. It is estimated that almost half of the food in the US is bought for health reasons and that functional food will soon constitute half of the entire food market (Siró et al., 2008).

Products supporting heart disease prevention, lowering the level of cholesterol in blood or reducing the symptoms of menopause have been dominating in Europe. It is estimated that the value of functional food in the EU will reach 40 billion Euro in 2020. The main categories of food for special purposes in Europe are dairy products (50% of turnover) and cereal products (30%), however, in Japan and the USA drinks constitute 60% of share in the market (Zębek and Szwejkowska, 2014).

The Development of Functional Food in Poland

The food market in Poland is not very innovative in terms of the offered choice of products. The offered products hold little attraction for consumers. There are no original or groundbreaking projects. The cooperation between science, business and the market is not effective. This impeded cooperation has led to the poor development of innovative food. In spite of Poland's efforts to implement new production technologies the progress of functional food is not so dynamic as in other countries of Western Europe, Japan or USA. However, experts say this is a characteristic feature for developing countries. Products and technologies which have already been proved in other countries are preferred (Rejman, 2004). The quality and safety of the food already present on the market is increasing. The following factors build the strongest barriers against the progress of functional food:

- Unfavorable administrative structure showing the lack of supporting institutions
- Hindered access to knowledge in the field of designing, technology and participation in international projects
- Poor flow of reliable scientific research from university centers to interested enterprises
- Passive attitude of entrepreneurs and their limited creativity
- Difficulties in obtaining funds for research and development
- Poorly implemented marketing of the functional products which already exist on the market
- Passive and conservative attitude of the end consumer
- Prices which are too high in relation to conventional food (Kaczorowska, 2009).

The world market is more experienced than the Polish market. More extensive knowledge and awareness of consumers, better access to healthy food, higher purchasing power and advanced technologies allow it to offer a wide choice of products. Poland is far behind in this respect; however, it is slowly making up for it. Although consumers are not able to mention any functional products which have already been present on the market,

they declare their interest for new innovative products. Health-promoting foods have been gaining more and more supporters. The value of this market in Poland is estimated at about 1.4 billion euro (Olejniczak 2014). Optimistic prognoses allow an assessment that highly satiating foods will be included into the functional food offered on the Polish and European market.

Innovative Foods and Polish Consumers

The steady progress of economic, social and cultural changes and the growing risks of diseases have led to the development of new types of food that are adjusted to the various requirements and needs of modern consumers. Unfortunately, new products that create new demand appear only sporadically on the market (Czajkowska et al., 2013). The market for functional foods in Poland is determined by many factors;

- Consumer behaviour;
- Food safety;
- Medical treatment and prevention;
- Lifestyle;
- Fashion and prestige;
- Social status;
- Price.

Apart from the above-mentioned factors, consumer choice of health-promoting foods for special purposes is determined by its freshness, sensory properties, verified information on the packaging and its real influence on health. For this reason, manufacturers face a very difficult task in meeting the precise requirements consumers.

Today's consumer expects innovations on the food market. The companies which introduce new solutions are perceived by customers in a better light. This has been confirmed by numerous studies (Gutkowska et al., 2014; Szul, 2016). Manufacturers should design their products on this rising wave. The consumer must be important not only at the last stage as the final purchaser, but also at the very beginning. He or she should be the inspiration and indication for creating new solutions. Women are the main recipients in the context of functional food (Górecka et al., 2009) and it is their needs that the food market, including the highly satiating food market, should be oriented toward. According to Skotnicka and Platta (2017), interest in such foods is high and people expect to find foods which help control body mass and enhance weight loss.

However, refining the term "functional food" is the most important thing from the point of view of the Polish consumer. In most of the studies the respondents do not distinguish between convenience, functional or genetically modified food available on the market. This causes big concerns before purchasing any upgraded, enriched, vital or designed food. These terms have negative repercussion and suggest that foods designated for special purposes are modified, processed and unhealthy, and there is the feeling that the designation of foods as "health-oriented" is being abused (Gutkowska et al., 2014). As long as the Polish consumer does not understand what the food designed for a particular group of recipients is and what its objectives are, the chances for success of such a production is burdened with a high level of risk. Nevertheless, the dynamic progress of this type of food all over the world shows that such a trend could be shortly carried over onto the Polish domestic market (Kaur and Singh 2017).

Functional Food and Obesity Prevention

Obesity is one of the most common diseases related to poor nutrition. The World Health Organization (WHO) reports that obesity is a global problem and that it is the greatest global challenge of the 21st century. The number of obese people has tripled during the last 20 years. The highest percentage of obese people on a global scale (36.7%) live in the countries of the Persian Gulf Cooperation Council (Quatar, Quwait, UAE, Bahrain, Saudi Arabia, Oman). A similar situation is found in the United States where 33.7% of citizens are obese. It is scarcely better in the European countries. Unfortunately, Poland is in 5th place among the countries having most obese citizens (25.2%). If untreated this disease leads to a number of diet related disorders: circulatory diseases, type 2 diabetes, metabolic syndrome, hormonal disorders, and an increased risk for certain types of cancer (Al Nohair 2016, Cuschieni 2016, WHO 2016, Eurostat 2014).

For this reason, obesity was included in the Global Food Security Index in 2014 as one of two new measurement factors, next to food loss levels. Excess weight and obesity are the result of the lack of balance between the energy acquired with food and the energy expended. In the context of counteracting against excessive weight and obesity, it is not only the number of consumed calories which is important but also a properly balanced diet, physical activity and changing inappropriate nutritional habits.

It is extremely important to intensify promotion of proper nutrition and physical activity, and to treat excess weight and obesity both among children and adults. However, in spite of broad awareness in the developed and developing communities, the problem of excessive consumption has already reached over 50% of Europeans. The World Health Organization declares that unless some radical measures limiting obesity are undertaken, the rate of mortality due to diet-related diseases will increase. However, using restrictive diets is often ineffective. It is difficult to keep the patient in the dietary regime for a long time. After some time the motivation and strong will stops and the reward deficiency syndrome appears. For this reason a lot of weight loss therapies are not effective (Eurostat, 2014).

The application of food supporting obesity treatment and having a high satiating potential can be one of the ways to suppress this tendency. Research conducted all over the world is oriented on creating innovative functional products based on the knowledge of scientists, physicians and dieticians (Rebello et al., 2014). Two models of division are most often used in designing functional food that supports the treatment of obesity. The first model emphasizes the influencing of human metabolism. The second model depends on the use of bioactive substance.

- Decrease of lipids absorption;
- Decrease of energy supply;
- Increase of energy expenditure of the organisms;
- Decrease of adipocyte proliferation;
- Inhibiting lipogenesis and intensification of lipolysis process (Kostecka et al. 2017);
- Application of nutraceutics (Włochal et al. 2014, Aggarwal 2010).

The second model classifies food in terms of the bioactive ingredient included in the product. A part of these substances is included in the food we eat on daily basis. However,

the goal of modern technology is to acquire these substances and use them in a condensed and active form in modern functional food (Lai et al. 2015, Myrie and Jones, 2011). The active substances indicating a slimming effect include: Apigenin, Capsaicin, Myricetin, Resweratrol, Piperin (Baboota et al., 2013). Table 1 shows the most commonly used bioactive substances.

Table 1. The main substances used for the production of food supporting the treatment of obesity

Bioactive substance	Mechanism of action	Active compounds	Food source	Study
Dietary fiber	Suppressing the sensation of hunger, ability to bloat, delaying the process of stomach emptying	Glukomannan Psyllium b-glucans Starch resistant	Plantago ovata, Plantago psyllium L., Flax Cereals	Lopez-Rubio et al. 2016 Zalewski et al. 2015 de Boer et al. 2016 Brum et al. 2016 Schultes et al.2016
Chitosan	Water absorption ability and the feeling of satiety	Chitosan	Obtained from crustaceans	Gallo et al. 2016 Lopez-Rubio et al.2016
Plant Polyphenols	Suppressing the appetite, decreasing the absorption of glucose, Apoptosis induction and inhibiting lipogenesis	Genistein (EGCG) Curcumin Quercetin Sillibinin	Green tea, Turmeric, Onion, Paprica	Mi et al. 2017 Hamdaoui et al. 2016 Ding et al. 2016 Moon et al. 2013 Ahn et al. 2008
Probiotics, Prebiotics	The recovery of normal intestinal flora	*Lactobacillus rhamnosus* *Lactobacillus Gasseri* *Bifidobacterium, Enterococcus, Sacharomyces boulardii*	Fermented dairy products	Karimi et al. 2015 Baboota et al. 2013

Source: own elaboration

The Chances for the Development of Highly Satiating Foods

Highly satiating food is food characterized by a high level of satiety while consuming the same isocaloric portion. It is a kind of food which, due to its chemical and physical properties, can satiate the body quickly and for a long time, invoking the sensation of satiety which delays the time of hunger occurrence and the time of starting the next meal (Tremblay and Arguin, 2013).

The new generation food market has been addressed for the last few years to people who want to improve their appearance, enhance the functioning of their alimentary system and control their body weight while limiting the use of supplements and drugs. One of the proposals is to design foods with a high satiating potential that suppress the sensation of hunger. Such foods should be rich in nutritional fiber, both soluble and insoluble, which

causes bloating of the stomach contents thus satiating for a longer time (Arguin et al., 2012). Furthermore, such a product should contain a proper amount of water or be suitable for hydration in the case of products designed for instant preparation. The content of water and fiber causes bloating in the stomach and, by the same, slows down the process of emptying the stomach and intestinal passage of the digestive contents. Additionally, each product could be enriched with antioxidants which would additionally enhance body mass reduction through regulating the metabolic processes. In Japan and USA different kinds of hydrocolloids such as glucomannan (Zalewski et al., 2015), guar gum (Li and Nie, 2016) or xanthan gum (Fiszman and Varela, 2013) are used for designing snacks and drinks.

Global Production of Highly Satiating Foods

More and more attention is given to the production of food dedicated to a particular social group. Among the functional foods designed for body mass control and used in obesity prevention, special consideration should be given to the substances or food products which have a high satiating potential. The task of food engineers is to manufacture foods which will satiate the human body for a long time, limiting snacking between meals. Presently, around the world, such types of food are produced especially in Korea, Japan, USA and Canada. The production involves manufacturing snacks such as specially designed bars and drinks with the addition of natural plant ingredients (Gruenwald, 2009) and ready meals to be served hot. Advantage is taken from the satiating properties of homogenized and comminuted foods (Campbell et al., 2016).

This kind of functional food is not yet so popular in Europe. However, Consorium Satin has been operating for several years, comprising the leading European Universities involved in the research and design of this kind of food. Comprehensive studies are being conducted aimed at providing a whole range of satiating products (Scarabottolo, 2015; Lopez-Nicolas et al., 2015).

Unfortunately, such food products are perceived in Poland as niche products. The domestic manufacturers do not recognize the niche existing on the market. The vast majority of persons who are on a diet and taking different preparations and supplements for weight loss would enthusiastically take the opportunity to purchase this kind of food. Many new generation food projects have come into being in university laboratories, but we are not looking forward to realizing it. Many projects carried out in academic laboratories are looking forward to their realization. The limited possibilities of introducing highly satiating food make the Polish market very poor or even question its existence at all. In this case, it is essential to understand the need for mutual cooperation of the world of science, food manufacturers and consumers to state their expectations.

Summary – Future Trends

Nowadays, the manufacturers in Poland do not perceive the potential connected with functional food, including highly satiating food. The tendency on the world market shows that consumer nutritional habits and preferences are subject to change. Consumers have become more aware of the influence of diet on the functioning of the body and susceptibility to different diseases. It has been estimated that the diet in 2100 will be far

different from what we eat now. Most probably, it will be based on food specially designed for particular population groups (Heinrich and Preito, 2008).

The nutritional dietary profile of highly developed and of developing communities has changed remarkably during the last 50 years (De Fries et al., 2015). Wide choices of food available on the market has allowed for making individual choices. It means that diet is not monotonous and it takes consumer requirements and preferences into account. On the other hand, the development of industry, processing technology and global distribution has brought about risks related to food consumption. Allergies, alimentary intolerances, overconsumption, genetically modified food, convenience food, low fiber food with high content of fats and carbohydrates has created a space for the development of the safe, organic and functional food.

It has been estimated that by 2050 about 50% of food will have health promoting and therapeutic properties. Innovative progress in food technology will bring many economic and social benefits and it will contribute to increasing food safety. Introducing highly satiating products into the market may draw a remarkable interest, especially in these times of obesity epidemic. The application of functional products with satiating properties may become another tool in obesity prevention. The optimistic perspectives for the development of designed food in the world would lead to the conclusion that the Polish market will soon offer a wide range of this kind of products.

Bibliography

Aggarwal, B.B. (2010). Targeting inflammation-induced obesity and metabolic diseases by curcumin and other nutraceuticals. *Annual Review of Nutrition,* 30, 173–199.

Ahn, J., Lee, H., Kim, S., Park, J., Ha, T. (2008). The anti-obesity effect of quercetin is mediated by the AMPK and MAPK signaling pathways. *Biochemical and Biophysical Research Communications*, 373(4), 545–549.

ALNohair, S. (2014). Obesity in gulf countries. *International Journal of Health Sciences*, *8*(1), 79–83.

Arguin, H., Gagnon-Sweeney, M., Pigeon, É., Tremblay, A. (2012). Functional food and satiety. Impact of a satiating context effect on appetite control of non-obese men. *Appetite*, 58(1), 354–363.

Baboota, R.K., Bishnoi, M., Ambalam, P., Kondepudi, K.K., Sarma, S.M., Boparai, R.K., Podili, K. (2013). Functional food ingredients for the management of obesity and associated co-morbidities – A review. *Journal of Functional Foods*, 5(3), 997–1012.

Berry Ottaway, P., Jennings, S. (2011). 2 – EU legislation and functional foods: a case study.W: Functional Foods (pp. 25–40).

Brum, J.M., Gibb, R.D., Peters, J.C., Mattes, R.D. (2016). Satiety effects of psyllium in healthy volunteers. *Appetite,* 105, 27–36.

Campbell, C.L., Wagoner, T.B., Foegeding, E.A. (2016). Designing foods for satiety: The roles of food structure and oral processing in satiation and satiety. *Food Structure*, in press.

Cuschieri, S., Mamo, J. (2016). Getting to grips with the obesity epidemic in Europe. *SAGE Open Medicine*, *4*,1-6.

Czajkowska, K., Kowalska, H., Piotrowski, D. (2013). Rola konsumenta w procesie projektowania nowych produktów spożywczych, *Zeszyty Problemowe Postępów Nauk Rolniczych*, 575, 23-32.

de Boer, A., Urlings, M.J.E., Bast, A. (2016). Active ingredients leading in health claims on functional foods. *Journal of Functional Foods*, 20, 587-593

DeFries, R., Fanzo, J., Remans, R., Palm, C., Wood, S., Anderman, T.L. (2015). Metrics for land-scarce agriculture. *Science*, *349*(6245), 238–240.

Ding, L., Li, J., Song, B., Xiao, X., Zhang, B., Qi, M., Huang, W., Yang, L., Wang, Z. (2016). Curcumin rescues high fat diet-induced obesity and insulin sensitivity in mice through regulating SREBP pathway. *Toxicology and Applied Pharmacology*, 304, 99–109.

Eurostat Statistics Explained: Overweight and obesity – BMI Statistics 2014. Accessed 2 October 2017 from: http://ec.europa.eu/eurostat/statistics-explained/index.php/Overweight_and_obesity_-_BMI_statistics.

Fiszman, S.,Varela, P. (2013). The role of gums in satiety/satiation. A review. *Food Hydrocolloids*, 32(1), 147–154.

Gallo, M., Naviglio, D., Armone Caruso, A., Ferrara, L. (2016). 13 – Applications of chitosan as a functional food. In: Novel Approaches of Nanotechnology in Food (p. 425–464).
Górecka, D., Czarnocińska, J., Idzikowski, M., Kowalec, J. (2009). Postawy osób dorosłych wobec żywności funkcjonalnej w zależności od wieku i płci. *Żywność, Nauka, Technologia, Jakość*, 4(65), 320-326.
Gruenwald, J. (2009). Novel botanical ingredients for beverages. *Clinics in Dermatology*, 27, 210-216.
Gutkowska, K., Kowalczuk, I., Sajdakowska, M., Żakowska-Biemans, S., Kozłowska, A., Olewnik-Mikołajewska, A. (2014). Postawy konsumentów wobec innowacji na rynku żywności. *Handel Wewnętrzny*, 4(351), 80-93.
Heinrich, M., Prieto, J.M. (2008). Diet and healthy ageing 2100: Will we globalise local knowledge systems? *Ageing Research Reviews*, 7(3), 249–274.
Hamdaoui, M.H., Snoussi, C., Dhaouadi, K., Fattouch, S., Ducroc, R., Le Gall, M., Bado, A. (2016). Tea decoctions prevent body weight gain in rats fed high-fat diet; black tea being more efficient than green tea. *Journal of Nutrition & Intermediary Metabolism*, 6, 33–40.
Kaczorowska, J. (2009). Innowacyjna działalność produktowa polskich przedsiębiorstw przemysłu spożywczego. *Zeszyty Naukowe SGGW Problemy Rolnictwa Światowego*, 7(22), 50-57.
Karimi, G., Sabran, M.R., Jamaluddin, R., Parvaneh, K., Mohtarrudin, N., Ahmad, Z., Khazaai, H., Khodavandi, A. (2015). The anti-obesity effects of Lactobacillus casei strain Shirota versus Orlistat on high fat diet-induced obese rats. *Food and Nutrition Research*, 59, 29273.
Kaur, N., Singh, D.P. (2017). Deciphering the consumer behaviour facets of functional foods: A literature review. *Appetite*, 112, 167–187.
Kostecka, M., Czernecki, T., Szot, P. (2017). Nutraceutyki - szansa dla zdrowia współczesnych konsumentów. *Przemysł Spożywczy*, 71(2), 36-40.
Lai, C.S., Wu, J.C., Pan, M.H. (2015). Molecular mechanism on functional food bioactives for anti-obesity. *Current Opinion in Food Science,* 2, 9–13.
Li, J.M., Nie, S.P. (2016). The functional and nutritional aspects of hydrocolloids in foods. *Food Hydrocolloids*, 53, 46-61.
Lipińska, I. (2015). Ryzyko innowacyjne w produkcji żywności – aspekty prawne i ekonomiczne. *Roczniki Naukowe SERiA*. 17(1), 129-134
López-Nicolás, R., Finlayson, G., Gibbons, C., Halford, J., Harrold, J., Leal, C., Ros-Berruezo, G. (2015). SATIN. SATiety INnovation. Development of a Satiety App to be used in different electronic hardware (smartphone or tablet) along human studies. *Appetite*, 91, 433.
Lopez-Rubio, A., Tarancón, P., Gómez-Mascaraque, L.G., Martínez-Sanz, M., Fabra, M. J., Martínez, J. C., Fiszman, S. (2016). Development of glucomannan-chitosan interpenetrating hydrocolloid networks (IHNs) as a potential tool for creating satiating ingredients. *Food Hydrocolloids,* 60, 533–542.
Martirosyan, D.M., Singh, J. (2015). A new definition of functional food by FFC: what makes a new definition unique. *Functional Food in Health and Disease*, 5(6), 209-223.
Mi, Y., Qi, G., Fan, R., Ji, X., Liu, Z., Liu, X. (2017). EGCG ameliorates diet-induced metabolic syndrome associating with the circadian clock. *Biochimica et Biophysica Acta (BBA) - Molecular Basis of Disease*, 1863(6), 1575–1589.
Moon, J., Do, H.J., Kim, O.Y., Shin, M.J. (2013). Antiobesity effects of quercetin-rich onion peel extract on the differentiation of 3T3-L1 preadipocytes and the adipogenesis in high fat-fed rats. *Food and Chemical Toxicology*, 58, 347–354.
Myrie, S.B., Jones, P.J.H. (2011). 10 – Functional foods and obesity. W: Functional Foods (p. 234–260).
Olejniczak, M. (2014). Zróżnicowanie technik badawczych w badaniu motywacji zakupowych konsumentów żywności funkcjonalnej. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu,* 336, 215-223.
Rebello, C., Greenway, F. L., Dhurandhar, N. V. (2014). Functional foods to promote weight loss and satiety. *Current Opinion in Clinical Nutrition and Metabolic Care*, 17(6), 596–604.
Rejman, K. (2004). Innowacje produktowe w rozwoju przedsiębiorstw sektora spożywczego. In: Nowoczesne zarządzanie i marketing w rozwoju przedsiębiorstw sektora rolno-spożywczego. Kowrygo B. (ed.). Wydawnictwo SGGW, Warszawa (p. 117-131).
Sardá, F.A.H., Giuntini, E.B., Gomez, M.L.P.A., Lui, M.C.Y., Negrini, J.A.E., Tadini, C.C., Lajolo, F.M., Menezes, E.W. (2016). Impact of resistant starch from unripe banana flour on hunger, satiety, and glucose homeostasis in healthy volunteers. *Journal of Functional Foods,* 24, 63–74.
Scarabottolo, L. (2015). SATIN. SATiety INnovation. Development of an in vitro platform to identify improved satiating food components. *Appetite*, 91, 435.
Schultes, B., Panknin, A.K., Hallschmid, M., Jauch-Chara, K., Wilms, B., de Courbière, F., Lehnert, H., Schmid, S.M. (2016). Glycemic increase induced by intravenous glucose infusion fails to affect hunger, appetite, or satiety following breakfast in healthy men. *Appetite*, 105, 562-566.
Siró, I., Kápolna, E., Kápolna, B., Lugasi, A. (2008). Functional food. Product development, marketing and

consumer acceptance - A review. *Appetite*, 51(3), 456-467.
Sokołowski, Ł.M. (2014). Z prawnej problematyki nowej żywności. *Przegląd Prawa Rolnego*, 1(14), 213-227.
Skotnicka, M., Platta, A. (2017). Zachowania konsumenta wobec żywności funkcjonalnej i wysokosycącej. *Handel Wewnętrzny*, 1(366), 319-328.
Szołtysek, K., Dziuba, S. (2006). Właściwości funkcjonalne żywności ekologicznej. *Journal of Research and Applications in Agricultural Engineering*, 51(2), 186-189.
Sztajerska, D. (2015). Żywność funkcjonalna w dorobku różnych dziedzin i obszarów zainteresowań. In: H. Marek, A. Zduniak (eds.) Bezpieczeństwo zdrowotne - ujęcie interdyscyplinarne (p. 221-241) Poznań.
Szul, E. (2016). Konsumenci wobec innowacyjnych produktów. *Nierówności Społeczne a Wzrost Gospodarczy*, 46, 226-236.
Tomaszewska, M., Bliska B., Grzesińska W., Przybylski W. (2014). Żywność funkcjonalna jako możliwość rozwoju polskich firm spożywczych. *Roczniki Naukowe SERiA*, 16(3), 293-298.
Tremblay, A., Arguin, H. (2013). 11 – Functional foods, satiation and satiety. In: Satiation, Satiety and the Control of Food Intake, 202-218).
World Health Organization (WHO). Obesity and overweight fact sheet. Accessed 9 September 2017 from: http://www.who.int/mediacentre/factsheets/fs311/en/ (2017).
Włochal, M., Grzymisławski, M., Bogdański, P. (2014). Możliwość wykorzystania żywności w leczeniu otyłości. *Forum Zaburzeń Metabolicznych*, 5(2), 51-62.
Zalewski, B.M., Chmielewska, A., Szajewska, H. (2015). The effect of glucomannan on body weight in overweight or obese children and adults: A systematic review of randomized controlled trials. *Nutrition*, 31(3), 437–442.
Zębek, E., Szwejkowska, B. (2014). Stan i trendy rozwoju w zakresie produkcji i wykorzystania żywności funkcjonalnej w kontekście prawnym. *Studia Prawnoustrojowe*, 24, 207-220.