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POSSIBLE USES OF FRUIT POMACES IN FOOD TECHNOLOGY AS A FORTIFYING ADDITIVE – A REVIEW

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Summary. Fruit processing industry contributes to increasing amount of food waste by-products. Among them there can be distinguished fruit pomaces generated in wine, cider or juice making process. Those wastes consist of bioactive compounds and dietary fibre what encourages scientists to design novel products with fruit pomaces added. There were described several products formulated with fruit pomace fortification. The main target for commercial pomace usage, are bakery goods: breads, muffins, biscuits, cookies. There is also a group of gluten-free products designed, and other experimental ways of fruit pomace application in novel foods preparation. Researchers examine their chemical, physical and sensory properties. Advantages of fruit pomace addition include improved nutritional properties of products: total phenolic content, total flavonoid content, antioxidative activity and dietary fibre level. Also, some qualitative, technological and sensory properties of those products may be enhanced. However, the pomaces addition gives the product various features that may lead to its decreased acceptance and quality.

Key words: fruit pomace, novel food, fortified food, food design, fruit by-products

INTRODUCTION

According to Food and Agriculture Organization of the United Nations (FAO) reports, the production of fruits reached over 1 billion t worldwide [FAO 2018]. Also, statistically, 45% of fruit or vegetable is wasted and this is the highest wastage value of all the foods [FAO 2011]. That reveals one of the main problems of fruit industry – management of food waste products. Conventional methods of fruit waste management include: animal

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feeding, landfilling, composting and biofuel production [Esparza et al. 2020]. One of the waste products of the fruit processing industry is a pomace which remains after juice extraction and contains cell wall compounds, seeds and skins [Quiles et al. 2018]. Depending on species of the fruit the composition of its pomace may vary. Although, most of them are characterised with high values of total phenolic content (TPC), total flavonoid content (TFC) and antioxidant activity (AO) [Peschel et al. 2006, Deng et al. 2012]. Also, dietary fibre (DF) content is high, but proportions of its fractions (soluble and insoluble) are various [Nawirska and Kwaśniewska 2005]. Such valuable compounds of fruit pomaces induce the need of their further use in food technology process [Majerska et al. 2019]. There are numerous reports about the use of pomaces obtained from grapes, apples, blackberries, blueberries, cherries, raspberries and cranberries processing. Pomaces used by researchers may come from fruit processing companies, e.g. winemaking or juice-making industries. Authors design food with various applications of fruit pomace as an additive. Commonly, pomaces are dried and added to products made of flour or to yoghurts, milks, cheese, snacks, etc. The aims of the pomaces usage in food industry are to lower the food waste amounts, to fortify foods with natural additives and to give them new sensory properties or improve their nutritional value [Campos et al. 2020]. This review is focused on changes in composition of nutrients, quality, technological and sensory properties of fruit pomace-added products designed by researchers in past ten years.

FRUIT POMACE AS BAKING GOODS ADDITIVE

Most widely described group of products fortified with fruit pomaces are baking goods such as bread, cookies, biscuits. In the process of baking goods preparation, fruit pomaces, after being dried and ground to a powder, are blended with flour. Scientists examine the technological and rheological properties of dough, composition of nutrients in final products and consumer perspective. A selection of novel bakery products developed by scientists is presented in Table 1.

A number of studies on the impact of fruit pomaces addition on bread properties have been carried out. Hoye and Ross [2011] studied on bread baked using wheat flour replaced at levels: 2.5, 5, 7.5 and 10% by grape seed flour made from grape pomace provided by winemaking company. Grape pomace addition negatively affected few features – it increased hardness and porosity of final product. Bread volume values, measured using rapeseed displacement method, decreased by 30% when 10% of wheat flour was replaced by grape seed flour, compared to the control. However, bread with pomace was firmer, as shown by texture profile analysis. The study revealed significant increase of TPC with increasing concentration of grape pomace. The sensory study showed low consumer acceptance of bread with 10% grape seed flour addition but other levels of pomace flour incorporation did not influence the overall acceptance of final products. Hayta et al. [2014] formulated bread by substituting 2, 5 and 10% of the bread flour with grape pomace provided by fruit processing factory. Some slight differences in qualitative characteristics of bread, compared to the control were reported: darker colour of bread crust and bread crumb and lower volume measured using rapeseed displacement method. A study on texture, using texture analyser, showed that hardness of bread increased

Table 1. Baking goods with fruit pomaces fortification

Tabela 1. Wyroby piekarnicze wzbogacane wytłokami owocowymi

Product Produkt	Amount and type of pomace Ilość i rodzaj wytłoków	Results Wyniki	Reference Źródło
Bread Chleb	2.5, 5, 7.5 and 10% of grape seed flour made from grape pomace	Increased TPC, acceptable to consumers. Darker colour, decreased volume, increased hardness and porosity.	Hoye and Ross [2011]
Bread Chleb	2, 5 and 10% of grape pomace	Increased TPC and AO. Darker colour, increased hardness.	Hayta et al. [2014]
Bread Chleb	2% of pear, apple and date pomaces in final product	Increased DF, improved dough performance. Difference in colour.	Bchir et al. [2014]
Bread Chleb	6, 10 and 15% of grape pomace	Higher TPC, greater stability and faster development of dough. Darker colour, intensive aftertaste, decreased volume.	Šporin et al. [2017]
Muffins Muffiny	10, 20, 30 and 40% of sour cherry pomace	Increased DF, TPC and AO. Higher amounts of pomace resulted in lowered consumers acceptance of colour, texture, sourness and fruity flavour.	Bajerska et al. [2016]
Brownies Brownies	10, 15, 20 and 25% of red grape pomace	Higher DF and AO, acceptable to consumers. Decreased firmness, darker colour.	Walker et al. [2014]
Biscuits Herbatniki	10, 20 and 30% of white grape pomace	Increase of DF, TPC and AO. Lower water absorption and dough stability, reduced hardness.	Mildner--Szkudlarz et al. [2013]
Biscuits Herbatniki	5, 10 and 15% of apple pomace	Increased water absorption and DF content. Decreased volume, lower colour and hardness scores.	Kohajdová et al. [2014]
Cookies Ciastka	25, 50 and 75% of apple pomace flour	Higher DF, TPC and AO. Decreased crunchiness with increasing content of apple pomace.	Zlatanović et al. [2019]
Sugar-snap cookies Kruche ciastka cukrowe	15 and 30% of apple pomace	Increased water binding and water holding capacities, higher taste scores of cookies with 15% of pomace replacement. Increased hardness.	Rocha Parra et al. [2019]

significantly within storage time and with increasing concentration of grape pomace in bread formula. What is more, some significant differences ($p < 0.05$) in TPC were observed: the addition of 5% of grape pomace increases the TPC almost twice, also AO of bread prepared with 2% grape pomace was two-fold higher, comparing to control. The sensory evaluation showed that pomace addition had no negative influence on the organoleptic characteristics. Bchir et al. [2014] prepared bread using wheat flour with 2% of pear, apple and date pomaces replacement. Pomaces were residues after syrup production. The results were consistent for all the pomace-added breads, with minor differences between them. The values of water absorption and dough stability in farinographic analysis were significantly increased, as compared to control. Also, alveographic analysis showed that doughs with pomace were more tenant and less extensible. There was no significant influence of pomaces on physical properties of bread such as volume or weight loss. The colour of fruits affected colour of crust and crumbs. The hardness of pomace-added bread was slightly raised, however increased significantly during storage. Šporin et al. [2017] produced bread using flour with 6, 10 and 15% supplementation of dried and ground grape pomace obtained from wine industry. Doughs and breads were examined for their performance and quality features. It was discovered that supplemented dough was more stable, and its development time was extended. Also, the crumb texture was stickier and less springy in breads made with grape pomace flour, comparing to the control. The consumers rated negatively some sensory features of bread like aftertaste, sand feeling in oral cavity. Nevertheless, TPC and AO of products prepared with grape pomace were significantly higher than in control breads.

Researchers also described some bakery goods made from sweet dough. Bajerska et al. [2016] described muffins with 10, 20, 30 and 40% wheat flour substitution with sour cherry pomace obtained in laboratory conditions. The study showed increased values of DF content, AO and TPC, especially high levels of cyanidines, coumaric acid and neochlorogenic acid in muffins prepared by replacing parts of flour with cherry pomace comparing to products without fortification. Sensory properties of muffins with up to 30% incorporation of cherry pomace into their formula, higher amount of pomace caused significantly darker colour, worse texture, stronger fruity and presence of sour flavour. Walker et al. [2014] studied on brownies formulated by substituting 10, 15 and 20% of the wheat flour with red grape pomace from wine production. Results showed that higher levels of pomace addition caused increased moisture content and darker colour of brownies. Also, some textural properties of brownies were changed – increased springiness, reduced firmness and chewiness, comparing to the control. TPC in brownies with fortification levels of 10–20% was significantly lower than in control product and did not changed significantly in brownies with 25% of grape pomace addition, although AO and DF content were increased. The sensory study resulted in overall acceptance of pomace-added brownies, however consumers pointed out significantly worse texture of products in comparison to the control.

Reports from few studies on snacks, such as biscuits and cakes, made with pomace addition are available. Mildner-Szkudlarz et al. [2013] prepared biscuits using wheat flour incorporated with 10, 20 and 30% of white grape pomace obtained from winemaking company. Farinographic analysis showed decreased water absorption and lower stability of dough, development time was not significantly different than in the control biscuits. Hardness of pomace-added biscuits measured using texture analyser was decreased. Authors reported that DF content was significantly increased, and its main fraction was insoluble DF. Incorporation of 10% of grape pomace resulted in 88% increase of DF content comparing to the control. Higher levels of pomace concentration in formula caused increased TPC with domination of gallic acid and tyrosol and stronger AO of biscuits. Kohajdová et al. [2014] described biscuits made from wheat flour replaced by 5, 10 and 15% of apple pomace prepared in laboratory. Farinographic analysis showed that water absorption level, dough development time and dough stability were increased comparing to the control. Volume of biscuits measured using rapeseed displacement method was significantly lower than in control product. Also, chemical composition of dry apple pomaces was investigated and compared to wheat flour. It was reported that DF and pectins contents in pomaces were significantly higher than in fine wheat flour. In sensory study, consumers rated properties of apple pomace-added biscuits, such as colour and hardness lower than the control. Moreover, biscuits with over 5% apple pomace blend obtained significantly lower consumers rates in such categories as taste, odour and overall acceptance.

Zlatanović et al. [2019] prepared cookies using apple pomace flour produced from apple pomace provided by fruit processing company. Levels of wheat flour replacement by pomace flour in cookies formulation were 25, 50 and 75%. DF content was significantly increased and reached nearly 6-fold higher values in cookies with 25% of apple pomace flour addition in comparison to the control. Also, TPC, TFC and AO increased significantly in fortified cookies. Sensory properties ratings of appearance, structure, chewiness, crunchiness and taste were lowered with increasing apple pomace percentage. Although, odour ratings were increased. It was concluded that replacing up to 50% of wheat flour with apple pomace flour is acceptable. Rocha Parra et al. [2019] characterised sugar-snap cookies made by substituting 15 and 30% of wheat flour with apple pomace provided by fruit processing company. Functional properties of apple pomace were examined. It was reported that water binding capacity and water holding capacity were higher for apple pomaces than for wheat flour. Measurements carried out using texture analyser showed that cookies enriched with apple pomace were significantly harder than control product. Also, pomace-added cookies were darker comparing to traditional sugar-snap cookies. According to sensory study, cookies with 15% apple pomace addition got significantly higher scores for taste in comparison to the control.

FRUIT POMACES AS GLUTEN-FREE BAKING GOODS ADDITIVE

Studies showed that gluten-free diet provides insufficient amount of dietary fibre [Miranda et al. 2014]. The main cause of that is lack of whole grain products. What is more, food restrictions resulted in higher amounts of both saturated and unsaturated fats in gluten-free diets [Vici et al. 2016]. As fruit pomaces are rich in fibre, they become promising additive to gluten-free flours to enhance the DF content. In Table 2 there are presented some of the bakery gluten-free goods recently formulated by researchers.

The main group of gluten-free products developed using pomaces as an additive are breads. Korus et al. [2011] prepared gluten-free bread with 5, 10 and 15% addition of defatted blackcurrant and defatted strawberry seeds obtained from pomaces. The results of textural and sensory properties measurements showed decreased hardness and darker colour of all pomace-added breads comparing to the control. TPC, DF and protein content values of fortified bread were significantly increased. The incorporation of up to 5% of blackcurrant seeds and 10% of strawberry seeds into bread formula did not resulted in any significant differences in sensory properties, comparing to the control. Gumul et al. [2020] used sour cherry pomace to substitute 10 and 20% of rice extrudate in gluten--free bread formulation in their study. Bread baked using maize starch, potato starch and 10% of rice extrudate was defined as control. Qualitative properties of fortified breads, such as volume and porosity were increased. Addition of pomace led to a decrease in breads' hardness and chewiness, also during storage. The study on chemical composition of gluten-free breads enriched with cherry pomace showed increased sugars and moisture

Table 2. Gluten-free bakery goods with fruit pomaces addition
Tabela 2. Bezglutenowe produkty piekarnicze z dodatkiem wytłoków owocowych

Product Produkt	Amount and type of pomace Ilość i rodzaj wytłoków	Results Wyniki	Reference Źródło
Gluten-free bread Chleb bezglutenowy	5, 10 and 15% of defatted black-currant and strawberry seeds from pomaces	Higher TPC, DF and protein, consumer overall acceptance. Darker colour, harder texture.	Korus et al. [2011]
Gluten-free bread Chleb bezglutenowy	10 and 20% of sour cherry pomace	Increased TPC, AO and volume, suppressed hardening of crumb. Higher sugars level and porosity.	Gumul et al. [2020]
Gluten-free cakes Ciasta bezglutenowe	5, 10 and 15% of apple and orange pomaces	High DF values in pomaces. Decreased volume, increased crumb hardness.	Kırbaş et al. [2019]
Gluten-free cookies Ciastka bezglutenowe	30% of blueberry and raspberry pomaces and 30% of both pomaces mixed in equal values	Higher DF and water absorption capacity. Notably increased hardness.	Šarić et al. [2019]

content. Moreover, TPC and AO were significantly increased. Total DF content was also higher in pomace-added breads, however the difference reached maximum level of 15% in comparison to the control.

Also, gluten-free, sweetened bakery goods were described by authors. Kırbaş et al. [2019] examined the effect of 5, 10 and 15% incorporation of apple and orange pomaces prepared in laboratory on cake features based on rice flour. Some changes in physical properties of enriched cakes were observed, apart from products with 5% of orange pomace addition which did not presented significant differences in comparison to the control. Pomaces addition caused an increase in crumb hardness measured using texture analyser and a decrease in bread volume measured using rape seed displacement method. Chemical properties of gluten-free flour mixtures (consisting of rice flour and dried pomace addition at a particular percentage) used in cake formulation were inspected. Powders containing pomace were characterised with significantly lower values of moisture and protein content and higher values of carbohydrates content. DF concentrations were analysed only in pomaces and DF content was higher in orange pomace than in apple pomace (ca. 69 vs. 45%). Sensory evaluation of cakes showed increased acceptance of 5% orange pomace-added cakes comparing to the cakes without fortification. Also, products with 5% of apple pomace and 10% of orange pomace additions were accepted by consumers without any significant differences between cakes formulated without pomace addition. Šarić et al. [2019] studied on cookies formulated using gluten-free flour with different levels of pomace substitution: 30% of raspberry pomace, 30% of blueberry pomace and 30% of mixed raspberry and blueberry pomaces in equal shares. Pomaces were provided by fruit processing company. Pure fruit pomaces were examined for their water absorption capacity using centrifuge technique. Blueberry pomace had significantly higher water absorption capacity than raspberry pomace. The main effect of pomace addition to cookies formula was reflected in increased hardness (up to 2.4-fold when only blueberry pomace was used) of final product, measured by texture analyser in comparison to the control. Cookies containing fruit pomaces were characterised with significantly higher DF content, with insoluble DF dominant. DF content of blueberry pomace-added cookies increased 49.7-fold in comparison to the control and reached the highest values of DF content amongst all samples.

OTHER FRUIT POMACE-FORTIFIED PRODUCTS

Not only the impact of pomaces addition on the bakery goods properties is a subject of studies. Certain novel pomace-added food products are presented in Table 3. The variety of products is large, including noodles, dairy products, snacks etc. Described foods were examined for their nutrients content, textural and sensory properties, and some specific aspects of products, for example the size of bacteria colony in yoghurts or water absorption in noodles.

Table 3. Other products with fruit pomace addition

Tabela 3. Inne produkty z dodatkiem wytłoków owocowych

Product Produkt	Amount and type of pomace Ilość i rodzaj wytłoków	Results Wyniki	Reference Źródło
Corn extruded snacks Kukurydziane przekąski ekstrudowane	10, 15 and 20% of rosehip and apple pomaces	Increased TPC, AO. Less acceptable taste, odour and texture, especially snacks with rosehip addition.	Drożdż et al. [2014]
Extruded snacks Przekąski ekstrudowane	10, 20 and 30% of apple pomace	Higher TPC, TFC, AO, DF.	Reis et al. [2014]
Noodles Makarony	5, 10, 15 and 20% of apple pomace	Acceptable texture profile and culinary quality. Increased hardness, gumminess.	Xu et al. [2020]
Yoghurt Jogurt	60 g of grape pomace per 1 kg of yoghurt	Increased TPC, AO, reduced fat. Sensory unacceptance.	Marchiani et al. [2016]
Yoghurt Jogurt	1.5 and 3% of apple pomace	Decreased syneresis, acceptable sensory properties. Less acceptable colour.	Znamirowska et al. [2018]
Spreadable cheese Ser do smarowania	5% of white and red grape pomaces	Increased TPC, TFC, AO. Worse spreadability, perceptibly fibrous.	Lucera et al. [2018]
Probiotic fermented goat milk Probiotyczne mleko kozie fermentowane	2 g grape pomace extract per 100 g of product	Higher TPC, enhanced flavour, colour. Decreased consumer acceptance.	Dos Santos et al. [2017]
Mustard Musztarda	15, 20 and 25% of blueberry and cranberry pomaces	Increased DF, TPC, AO. Sensory features received low rates.	Davis et al. [2018]

Several reports about snacks fortified with fruit pomaces were found. Drożdż et al. [2014] studied on corn extruded snacks made from corn grits with 10, 15 and 20% content of rosehip and apple pomaces obtained from fruit processing industry. Values of TPC as well as AO of snacks containing pomaces increased significantly with increasing pomaces concentration compared to the control and were higher in snacks with rosehip pomace. Sensory evaluation showed that both rosehip and apple pomaces negatively affected shape, size, structure, taste and odour of snacks. However, organoleptic differences between snacks with apple pomace and the control were relatively constant with increasing pomace content and not as significant as in snacks with rosehip. Reis et al. [2014] prepared extruded snacks using rice flour, wheat semolina and incorporation of 10, 20 and 30% of apple pomace provided by cider factory. Addition of pomace led to significant increase of DF content, TPC, TFC, proanthocyanidins content and AO in comparison to control. Xu et al. [2020] examined Chinese raw noodles formulated using flour with 5, 10, 15 and 20% addition of apple pomace obtained as by-product from juice processing company. The incorporation of pomace in noodles formula resulted in significantly higher cooking loss, however the values of that parameter were not affected by increasing apple pomace concentration. Water uptake was also significantly increased in noodles with pomace addition, but the values raised with the increasing content of apple pomace. Also, the impact of pomace addition on noodles texture parameters measured using texture analyser was determined. There were observed increased values of hardness, gumminess and chewiness and decreased values of cohesiveness as the only parameter not affected by amount of pomace. It was concluded that textural properties and cooking quality of pomace-added noodles were acceptable, with the most promising results for 5 and 10% of apple pomace replacement.

Furthermore, various dairy products with fruit pomaces incorporation were designed. Marchiani et al. [2016] introduced yoghurt with sterile grape seed flour added in concentration of 60 g per 1 kg of yoghurt. The grape seed flour was made from grape pomaces provided by winemaking companies. Pomace addition caused an increase in the yoghurt's acidity, syneresis, TPC (with prominent compounds: catechin, quercitrin and rutin), AO and sugars content. Furthermore, TPC and AO were constant throughout the storage time. Also, fat content was reduced in fortified yoghurts. Results of microbiological analysis showed that the addition of grape seed flour had no influence on bacteria number in final product. Grape seed flour addition led to a decrease in the scores for appearance, odour, taste (i.e. sourness), flavour and texture of yoghurt in comparison to the control. Znamirowska et al. [2018] formulated yoghurt containing 1.5 and 3% apple pomace provided by fruit processing company. Apple pomace addition resulted in significantly increased acidity, decreased syneresis and darker colour of yoghurt comparing to the control. Also, decreased values of adhesiveness and thickness were observed in texture analysis done using texture analyser. Sensory evaluation showed that 3% apple pomace-added yoghurt was preferred regardless of its unattractive colour and consistency. Perceptible apple taste and odour were rated as acceptable. Lucera et al. [2018] created spreadable cheese with 5% of red and white grape pomaces addition obtained from fruit and vegetables processing company. Cheeses containing grape pomaces were characterised with lower acidity and moisture compared to the control. TPC, TFC and AO of cheeses fortified with both types of pomaces were significantly increased with slightly higher values in samples of white grape pomace-added products. The sensory study showed that pomace addition affected the flavour of cheese, which was described as less sweet and less salty but more acidic and astringent than control product. Enriched cheeses received lower scores for their textural properties such as spreadability and juiciness, cheeses with pomace addition were also assessed as fibrous in comparison to unfortified one. Dos Santos et al. [2017] formulated probiotic goat milk with addition of 2 g of grape pomace extract per 100 g of product. Extract was obtained by processing grape pomace from winemaking company. Milk containing grape pomace extract was characterised with significantly higher acidity which increased during storage in comparison to the control. TPC in enriched fermented milk was enhanced and remained at the same level regardless the storage time. Microbiological analysis showed that grape pomace extracts did not significantly affect survival of probiotic bacteria. The addition of pomace extract into probiotic milk had negative influence on the organoleptic characteristics (flavour, colour and overall acceptance).

There is also an example of condiment prepared with fruit pomace addition. Davis et al. [2018] prepared mustard fortified with 15, 20 and 25% blueberry and cranberry pomaces provided by a producer of concentrated fruit juices. Studies on physical and chemical properties showed that values of moisture content, pH and darker colour of mustards with pomaces were increased. DF (mainly insoluble fraction) content increased significantly with increasing pomace concentration. Also, AOs of mustards containing pomaces were stronger, comparing to the control. TPC measured after simulated gastrointestinal digestion was increased, although the parameter measured after chemical extraction was not significantly different than control. Consumers rated mustards as too dark and too fruity-flavoured.

CONCLUSIONS

To fulfill the conditions of the circular economy model, recovery of fruit industry by-products should be widely considered. Adding fruit pomaces to food technological process results in products of improved nutritional values concerning TPC, TFC, AO, DF content and new sensory characteristics. However, the impact of fruit pomace addition on the product's qualitative properties and consumer acceptance may be negative. Considering rheological properties, baking quality parameters and organoleptic characteristics of baking goods, decreased volume, dough stability, consumers acceptance, increased hardness and gumminess were noticed. Authors described similar effects of the incorporation of fruit pomaces on gluten-free products dough performance and quality. Other products containing fruit pomaces were characterised with the lower consumer acceptance. Only a few studies focused on reporting detailed data about phenolic content, durability and sensory evaluation of products during storage. The differences in all parameters among presented products result from the type and amount of pomace used in product preparation. This review exposes possibilities of future studies on specific phenolic components of products with pomace addition, impact of pomace particle size on final parameters of the product, designing a new range of food products with different levels of pomace addition and examining their stability during storage.

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MOŻLIWOŚCI WYKORZYSTANIA WYTŁOKÓW OWOCOWYCH DO PRODUKCJI ŻYWNOŚCI WZBOGACANEJ

Streszczenie. Przetwórstwo owocowe w znaczącym stopniu przyczynia się do zwiększania liczby produktów odpadowych przemysłu spożywczego. Wśród odpadów generowanych przy przetwarzaniu owoców można wyróżnić wytłoki owocowe powstające w procesie produkcji wina, cydru lub soków. Odpady te zawierają w swoim składzie związki bioaktywne i błonnik pokarmowy, co zachęca naukowców do projektowania nowatorskich produktów z dodatkiem wytłoków owocowych. W pracy opisano kilka produktów z dodatkiem takich produktów odpadowych. Główną grupą produktów z możliwością wykorzystania wytłoków są wyroby piekarnicze: pieczywo, babeczki, herbatniki, ciastka. Istnieją również produkty bezglutenowe oraz inne eksperymentalne produkty spożywcze wytworzone z wykorzystaniem wytłoków owocowych. Naukowcy badają właściwości chemiczne, fizyczne i sensoryczne nowoopracowanych produktów. Zalety dodatku wytłoków owocowych uwzględniają zwiększone właściwości odżywcze: całkowitą zawartość fenoli, całkowitą zawartość flawonoidów, aktywność przeciwutleniającą i zawartość błonnika pokarmowego. Polepszeniu ulegają również niektóre właściwości jakościowe, technologiczne i sensoryczne tych produktów. Pojawiają się jednak cechy nowych produktów, które mogą spowodować, że będą one mniej przydatne i akceptowalne.

Słowa kluczowe: wytłoki owocowe, nowa żywność, żywność wzbogacona, projektowanie żywności, owocowe produkty uboczne