

Summary

In recent years, there has been a growing trend on the plant food market. The market value of vegetable meat substitutes in the world in 2019 was \$ 11.1 billion. It is predicted that the current growing trend will continue and in 2027 this market will be worth up to \$ 35.5 billion.

Vegetable analogues based on cereals and soybeans constitute the largest segment. Tofu is one of the most recognizable meat alternatives and one of the most popular plant products in Poland, right behind hummus, soy chops and plant-based drinks. Tofu is an unfermented soy product that is often compared to cheese. It is characterized by a firm consistency and a delicate flavor, ranging in color from white to pale yellow. Tofu is a source of protein and amino acids for the entire population, especially vegetarians and vegans. It is a low-calorie product, free from cholesterol, saturated fat and lactose. Tofu on a dry weight basis contains about 8% protein, 4-5% fat, 2% carbohydrates and 1% dietary fiber. A 100 g portion of tofu can contain about 4.13 mg of iron and 0.32 mg of copper, therefore consumption of this product is recommended in the diet of vegans as a source of these bioelements. The tofu processing process may vary from producer to producer, but the basic steps in the production process include soaking and grinding soybeans, cooking soy milk, and adding one or more coagulants. In the tofu production process, several parameters can have significant impact on the final product. These include the grain to water ratio, the type, amount and temperature of the coagulant used, the coagulation time as well as the strength and pressing time of the curd. The process of producing tofu begins with the preparation of "milk" (that is, the water seed extract), which consists of several steps. In the first one, grains are selected and cleaned. In the next step, the beans are soaked, then mixed with water, ground and filtered. After the filtering process, the raw soy "milk" is separated and gently heated. The coagulation stage is the most important step to achieve good tofu texture and performance, which are important determinants of product acceptance by producers and consumers and is the most difficult step to control in the production of tofu because it depends on many variables. The gelation, taste, efficiency and texture are influenced not only by the type and concentration of the coagulant used, but also by the speed of mixing, the duration of the coagulation and the temperature of its addition. Agitation is necessary to obtain a suspended coagulant, so the speed and time of agitation should be sufficient to maintain it evenly distributed throughout the soy "milk". The formation of the tofu affects the hardness of the final product. Determining the ideal hardness value is not possible as it depends on the preferences of consumers and the intended use of the finished product. The pressure and the pressing time affect the composition and texture of the tofu.

Soybean sprouting can be another way to prepare the raw material for production. This stage reduces anti-nutritional substances such as trypsin inhibitors or phytates. During this process, a sequence of metabolic changes takes place, which improves the nutritional value of these seeds. The sprouted varieties can produce tofu with an increased protein content, whiter color and lower fat content compared to non-sprouted seeds. Another product produced from soy is tempeh, which is a globally accepted fermented Indonesian product and functional protein source. It is most often produced from soybeans or other leguminous seeds and grains of cereals, which are fermented with *Zygomycetes* class fungi. Seitan, which is also referred to as "wheat meat" or "wheat gluten", is another plant-based alternative for meat. It is made by washing the starch contained in the wheat flour with water until obtaining a sticky, insoluble gluten in the form of an elastic mass. It consists of the protein components of gliadin and glutenin. Mushrooms can also be used as substitutes for meat. Mycoproteins are an alternative source of protein, produced from the naturally occurring fungus *Fusarium venenatum*. Commercially, mycoproteins are used as an ingredient in products sold in 17 countries under the Quorn® trademark and are in the form of e.g. chops and also imitations of minced meat. Textured Vegetable Proteins (TVP) are processed plant proteins that can be used to completely replace meat in a portion of food. They are made of high-protein mixtures of isolated and concentrated proteins derived from plant sources. A good raw material for their production are legumes, which contain about 25-50% of protein.

Consumer behavior is related to the attitudes. They can be defined as a relatively constant human tendency with a positive or negative attitude towards a given object (e.g. soybean and hemp tofu). The overall attitude towards the product is therefore the sum of emotional feelings and opinions towards each feature considered important by the consumer. Attitude is seen as one of the main determinants of the consumer's intention to perform a given behavior, and the measurement of attitude is important because it plays a role in determining the position of the product by consumers. The consumer is accompanied by various sets of determinants during the decision-making process. With regard to basic food products, the most important are economic factors (income and price) as well as social factors (family, social groups, reference groups, lifestyle or cultural influences). In the case of luxury food products, psychological determinants (attitudes, perceptions, needs, motives, emotions, personality) and marketing determinants (product features, price, advertising or place of sale) are of greater importance.

People who buy soy products, including tofu, may be aware of the health information of this type of product when making their purchase. Consumers struggling with diseases such

as celiac disease, milk allergy, wheat allergy, and non-celiac gluten sensitivity cannot consume gluten, which is a component of e.g. vegetable analogs for meat. Cow's milk allergy is one of the most common type of food allergy, caused by the immune system's response to binding immunoglobulin to cow's milk proteins and can cause an allergic reaction in allergic individuals. Clinical studies have shown that some of the ingredients in this product can cause not only allergies, but also e.g. lactose intolerance. Alternatives to milk may also be sought by those concerned about the hormone and antibiotic content of dairy cattle, as well as the level of saturated fat. The next most common products that causes allergies are soybeans. Soy is one of eight products that account for 90% of all allergic reactions, and 0.4% of children and 0.3% of adults are estimated. Due to its properties, soy is often used in food production in the form of not only fresh grains, but also flakes, oil, flour, grits and milk. The most commonly used plants used in transgenic crops are soybeans, corn, cotton, and rapeseed. This type of soy is found in foods, including tofu, natto, miso, soy sauce, protein isolates and soy "milk". Genetically modified organisms can positively influence the quality and appearance of products. As soy is one of the dominant transgenic plants and contains allergens, consumers may show a demand for tofu produced from raw materials other than soy from other raw materials, which may be hemp. The dynamic development of the functional food sector, bio-based products and gluten-free products increased the importance of cannabis cultivation. Consumers are looking for products with pro-health properties, which is associated with an increase in their awareness of sustainable food production. Consequently, hemp-containing foods are gaining in popularity. Hemp are one of the oldest cultivated plants. Almost 600 different compounds have been identified in seeds, leaves and inflorescences of *C. sativa*, incl. flavonoids, dihydrostilbens, phenanthrenes, spiroindanes, of which the most interesting group are phytocannabinoids, which are natural metabolites produced by cannabis. Taking into account the content of Δ^9 -tetrahydrocannabinol and cannabidiol, cannabis can be divided into: narcotic phenotype (over 0.5% THC, CBD lower than 0.5%), intermediate (main component of CBD, presence of THC in various concentrations) and phenotype fibrous (containing a small proportion of THC). The content of these bioactive compounds in cannabis is influenced by environmental conditions, the development phases of cannabis and its parts, the interaction of genetic factors and the method of cultivation. *Cannabis sativa* (called fibrous hemp) is characterized by tall growth, widely spaced branches and long, thin leaves. It is an annual plant suitable for growing both indoors and outdoors and adapts to different conditions so they can be cultivated in a wide variety of environments and latitudes. In the Polish climate, the optimal sowing date is the end of April or the beginning of May. Growing cannabis has many agricultural benefits, such as

soil improvement by plant rotation, weed control and the elimination of pesticide use due to the plant's resistance to pests. In addition, Cannabis requires much less water compared to corn or sugar beet crops. The laws governing the cultivation of cannabis are different in various countries. In Poland, after meeting the relevant formalities, such as a cultivation permit, only the cultivation of *C.sativa* is allowed. Cultivation may only be carried out for the needs of the textile, pulp and paper, chemical, building materials, cosmetics, pharmaceutical, food and seed industries. In Poland, in connection with the long-standing tradition of hemp cultivation, several types of hemp, adapted to our climate, have been bred. Despite the adaptation of the varieties to the climatic and soil conditions, the limitation of crops in Poland and other countries is due to the lack of appropriate machinery for harvesting and processing crops. Taking into account the area of all the lands intended for cultivation, the area of hemp sown in Poland is less than 0, 3%. Compared to other European Union countries, Poland has 7% of the sown area in the EU. In general, all parts of the plant are used (leaves, stems, seeds and resin) in such industries like e.g.: automotive, pharmaceutical, cosmetic, construction.

Hemp has a wide range of uses, including also the food sector, e.g. to obtain shelled/unshelled seeds, oil cakes, oil, flour, and protein isolate. Hemp seeds may contain over 35% fat, of which saturated fatty acids, especially palmitic and stearic acids, constitute only about 10%. Essential fatty acids (EFAs) are even from 75% to 90%, and the ratio of linoleic acid (ω -6) and α -linolenic acid (ω -3) in them is 3:1 and is considered optimal in the diet. The presence of long-chain polyunsaturated fatty acids in this raw material is considered unique as it is not found in any other commonly grown oilseed seeds. Hemp seeds are also rich in natural antioxidants such as phenolic compounds, tocopherols and phytosterols. Due to the fact that fat is an essential component of hemp seeds, oil is the main product produced from them. This oil has antimicrobial and anti-inflammatory properties, which are related to the presence of sterols in the seeds.

Hemp seeds also contain about 25% of protein. A higher content of this organic compound occurs in shelled seeds (about 31%), and its structure in the raw material is influenced by such agronomic factors like the type of soil, the kind of used fertilizer, rainfall or temperature. In cannabis seed 181 proteins were identified, with the two main proteins are the source of essential amino acids being water-soluble albumin (25-37%) and salt-soluble edestin (67-75%). Hemp seed proteins additionally contain a high concentration of glycine and histidine, and their isolate is characterized by a higher content of sulfur-containing amino acids compared to the soy protein isolate. The amount and type of protein found in seeds is the main biochemical component that determines the quality of not only the seeds themselves, but also

the products made from them. Hemp protein powder is popular among vegans, athletes and bodybuilders because it allows you to increase the supply of this macronutrient in the diet. Hemp seed flour is also added to the food, which increases the nutritional value of bakery products. There are two companies on the Polish market that produce tofu from hempseeds or with addition of hemp (e.g. extracts) (Pro Soya and Look Food). The market of alternative beverages of plant origin (e.g. hemp) is developing rapidly. However, there are no flavored (sweet) versions of this kind of products.

Therefore, the aim of the study was to determine the attitudes of consumers towards hemp and soy tofu, to define a potential consumer segment for hemp tofu and to develop a recipe for a new tofu product based on hemp seeds. For the purposes of the study, two questionnaires were prepared, one of which examined the attitudes of consumers (stage I), while the other checked their preferences (stage II). The second questionnaire included both single-choice and multiple-choice questions as well as open-ended questions. Prior to the preparation of the questionnaire of the survey in stage I, 10 people aged 18-55 who consumed tofu were interviewed. Stage III was connected with the development of new version of hemp tofu. As a part of this work, 7 research hypotheses were also formulated.

Electronically collected (CAWI) data was developed using the PQStat statistical program (PQStat Software, version 1.8.2, Poznań, Poland) and the MS OFFICE package (Excel 2016). In this work, the independence test χ^2 was used to check the relationship between the analyzed variables, while the strength of the relationship was determined on the basis of the C-Pearson coefficient for nominal scales and the Spearman's rank correlation coefficient (r_s) for rank scales. Statistical analysis of the results of the organoleptic evaluation, nutritional value and texture was performed using one-way analysis of variance for repeated measures (ANOVA). The mean and median were also calculated for the obtained results. The multi-attribute Fishbein model was used to determine the attitudes of consumers towards soy and hemp tofu. This model assumes that the attitude towards the product is based on knowledge about both the product itself and its attributes. The list of attributes, which was used to examine attitudes in accordance with the Fishbein model, was prepared on the basis of the data contained in the literature and the respondents' responses obtained during the interviews. The questions included such features as price, quality, taste, packaging appearance, nutritional value, health-promoting properties, purchase availability, smell, texture and composition. The MODE (Motivation and Opportunity Determinants) model, belonging to the single attitude model, predicts specific behaviors based on general attitudes. Motivation and opportunity are determinants that determine whether available attitudes affect behavior in an automatic or more

controlled way. This model was used in this study to measure the consumer's intention to re-purchase hemp tofu or, if the consumer has never consumed such tofu, the possible chance of purchasing it. In the prepared tofu (Stage III), the physico-chemical values were determined: dry weight, yield, protein, dietary fiber, total fat, saturated fatty acids, total ash, total carbohydrates, digestible carbohydrates, energy value, texture, sodium and salt. The selected different variants were assessed in terms of organoleptic analysis. Appearance, taste, overall acceptability, smell and texture were taken into account. The evaluators could give the attributes points on a 5-point hedonic scale, with 1 representing the lowest point and 5 the highest. Sensory analysis was performed with a simple descriptive test.

In the survey (stage I) 385 people participated and taking into account gender, more women participated comparing to men (79,74%). The vast majority of the respondents are from cities with more than 100,000 inhabitants (both for women and men). Responses to the average monthly net income were relatively evenly distributed, however, the most indications were obtained from people with a net income from 2,000 to 2,999 pln per month (22.08%). Respondents with higher (50.91%) and secondary (43.12%) education accounted for 94.03% and 69.09% of the respondents were people aged 21-35 (both in the group of women and men). One of the research questions was to identify groups of tofu consumers, which were designated on the basis of the frequency of consumption of this product. Typology was made according to demographic and social characteristics (gender, age, education, size of the place of residence and average monthly net income). The people who most often consumed tofu (daily or several times a week) were women (72,73%), people aged 21-35 (65,39%), people living in cities with more than 100,000 inhabitants (59,61%), people with an average monthly net income of up to 1,000 pln (21,15%), 1,000-1,999 pln (17,95%) and 2,000-2,999 pln (23,72%). Tofu was consumed more often by people with secondary education (52,56%). There was no statistical correlation between sex and the frequency of purchasing tofu, therefore, the H1 hypothesis (women buy tofu more often than men) has not been positively verified, despite the fact that in the group of people declaring consumption of tofu, both in the 1st and 2nd stage, women are definitely dominant (79,74% and 78,24 respondents, respectively). In Europe, men consume more meat than women, while dairy products, fruit and vegetables are seen as typically female food. Also, the popularity of veganism and vegetarianism among women is greater. The reason for this may be the fear in men of being negatively perceived both in their own eyes and in the eyes of the social group. It can also be influenced by the motivation to follow diets, as one of the main reasons for the transition to veganism or vegetarianism are health problems, and women have a higher level of awareness and better knowledge about nutrition compared to

men. Men show a more negative attitude towards a vegetarian diet also due to the taste of the dishes.

Taking into account the demographic and social criteria, only the dependence of the frequency of consumption of tofu on the level of education turned out to be significant, and people with lower education more often eat tofu (every day /several times a week) than respondents with higher education. Thus, the H3 hypothesis was rejected (the education of the respondents correlates positively with the frequency of purchasing tofu). Assumed hypothesis H2 (the amount of income positively correlates with the frequency of purchasing tofu), also has not been positively verified.

In recent years, research related to consumer behavior in the food market has become more and more important, as it is an element of building customer relationships, due to the knowledge of the motives, decision-making process, perception of products and preferences. It is also important to know the attitudes of consumers. Respondents showed a positive attitude towards the use of hemp seeds in food and considered this a positive trend. Considering that only 2,86% of the respondents (phase I) declared that they consumed hemp tofu, it can be assumed that for soy tofu consumers, hemp tofu is a novel / innovative food.

In the next section of the questionnaire, respondents were asked about importance of the attributes for both soy and hemp tofu (price, quality, taste, packaging appearance, nutritional value, health-promoting properties, purchase availability, smell, texture and composition). Based on the obtained results, it can be concluded that, according to the respondents, the appearance of the soybean tofu package is the least important feature ($x_{avg.} = 2,96$, $M = 3$). Similar results were obtained with hemp tofu, although the mean for this response ($x_{avg.} = 3,36$, $M = 6$) was higher than for the soybean version of this product. The feature with the highest mean in both the first and the second case is taste ($x_{avg}=6,35$ for soy tofu and $x_{avg}=6,27$ for hemp tofu, the median for both types of tofu was 7). It is taste that is one of the most important factors in consumer choice of food products. It was examined whether the gender of the respondents had an influence on the assessment of the importance of tofu flavor. The analysis performed using the χ^2 test showed no statistically significant differences for both soybean and hemp tofu. An important dominant was also quality, which was rated higher for hemp tofu ($x_{avg} = 6,17$, $M = 7$), which may indicate that consumers expect higher quality from non-standard products. The price was the parameter declared as more important for hemp tofu ($x_{avg} = 5,89$, $M = 6$) compared to soybean tofu ($x_{avg} = 5,41$, $M = 6$). In the next question, the respondents' beliefs about having certain features by soy and hemp tofu were checked. People in the stage I study most agreed with the statement that soy tofu should be of good quality ($x_{avg} = 6,47$, $M = 7$) and with the

decent price ($x_{\text{avg}} = 6,13$, $M = 6$). The third place was taken by the natural composition with an average of 6,11 and a median of 7. Similar results as for soy tofu were obtained for hemp tofu - respondents were most convinced that this type of tofu should be of good quality ($x_{\text{avg}} = 6,32$, $M = 7$). Natural composition and affordable price came second for both types of tofu. Respondents also largely agreed with the statement that hemp tofu should contain ingredients that have health-promoting properties and the statistical analysis of this results showed a relationship between respondent`s answer and the education and age. People with higher education agreed more with this statement. People agreed least with the statement that tofu should have interesting packaging (for both type of tofu).

There are many studies in the literature on consumer attitudes and behavior towards food, in particular transgenic, functional, ecological and novel food. With regard to functional food, the research investigated, among others, attitudes taking into account the age and gender of respondents and changes in consumer attitudes. The customers' beliefs and attitudes in predicting the intentions of buying organic food, the attitudes and behavior of consumers in the organic food market, attitudes regarding the consumption of organic fruit and vegetables based on the model of Ajzen and Fishbein, but also towards Italian consumers' sustainable food. The attitudes of consumers towards GM food in Europe were compared, as well as the relationship between individual attitudinal attributes. The attitudes and behavior of consumers were analyzed, as well as factors influencing the choice in relation to individual food products, such as, for example, meat products, fermented milk drinks or various types of soy products, including paneer cheese, milk, flour and flakes, tofu. However, there are no studies in the literature on consumer attitudes and behavior in relation to hemp tofu. In the research discussed in this doctoral dissertation the highest attitude was noted in relation to quality, composition and price (in the case of both soy and hemp tofu). In both cases, the respondents showed the lowest attitude towards the texture and appearance of the packaging. Differences appeared for the attitude for taste and purchase availability (higher for soy tofu) and for the nutritional value, the attitude of which was rated higher for hemp tofu. The average attitude of respondents towards soybean tofu was 301,43, while the average attitude towards hemp tofu was 313,76 (where the maximum possible score was 490). People with a very negative attitude towards soy tofu were not noticed, while for the hemp version it was 1.04%. In terms of gender, women (307,40 and 318,41, respectively) showed higher attitudes towards soy and hemp tofu. Regarding the place of residence, for soybean tofu people living in the countryside showed the highest attitude, while for hemp tofu they were from cities with 5,000 to 19,999 inhabitants. Taking into account education, for both types of tofu a higher attitude score was obtained for

people with secondary education. Positive attitudes towards soy tofu were also shown by respondents in a study by Kumar et al. (2009) who, using the Fishbein model, assessed consumers' attitudes also towards other soy products, such as milk, oil, flour, flakes and tofu. Consumers showed the most positive attitudes towards soy milk and tofu.

The MODE model was intended to measure the consumer's intentions to re-purchase or the chance to buy hemp tofu. Most people would decide to buy hemp tofu if a promotion appeared in the store (89,87% of answers 3 and 4). As income increases, the probability of buying hemp tofu when there is a promotion in the store decreases. This allowed for a positive verification of the H4 hypothesis (the amount of income negatively correlates with the probability of buying cannabis tofu when there is a promotion in the store). Promotion is a factor that triggers the desire to buy in people with lower incomes, while people with higher incomes do not need additional economic incentives to reach for tofu. Another aspect encouraging to buy would be a recommendation from friends (87,27% of people would probably or definitely buy this type of tofu). Information from friends encouraging to buy hemp tofu would definitely encourage women to buy (54,72% of answers 4) than men (38,46%). Information obtained from other consumers is also an important opinion-forming element in relation to a novel food and is rated higher than information obtained from other sources. If the person sharing the opinion on a given topic is appreciated by us (e.g. friends, family), the information obtained in this way allows to rationalize the purchase of new food. The information on the packaging "Non-GMO" would not have a significant impact on the purchase (most responses 1 and 2), which may seem a bit surprising, taking into account the general attitude of consumers to this type of food. Many European consumers show negative attitudes towards the use of genetic modification in food production. The information on the packaging referring to the lack of genetically modified organisms in the product is a greater motivator to purchase for people with lower education. Summing up, on this basis, the H6 hypothesis was negatively verified (more educated people are more likely to buy hemp tofu when they notice "non-GMO" on the packaging).

The total sum of answers 3 and 4 was 74,03%, which proves that such a percentage of respondents would buy or decide to buy hemp tofu again. It should therefore be stated that the motivation for purchasing hemp tofu by the respondents is high. In general, The MODE model allowed for the determination of the consumer's intentions at the time when his motivation and cognitive factors influencing the decision-making were present. Therefore, the people taking part in the study acted in a reflective manner, considering, aspects such as promotion in the store or recommendation of the product by friends. Thus, they were not only based on the demonstrated largely positive and very positive basis for hemp tofu, but also on other aspects

related to the given behavior. This may be due to the fact that due to the low knowledge of the product, which is hemp tofu, their attitude is not strong enough to be associated with a relatively permanent record in the minds of consumers, but it could have been created in a given situational context, based on the information that was just available. It can therefore be assumed that after the strengthening of the attitude towards cannabis tofu, which will take place after closer acquaintance with the product, purchasing decisions will be made more spontaneously and will be based on a positive or negative attitude. It was checked whether gender determines the likelihood of buying hemp tofu in a situation when a sweet flavored version is available. The appearance of an interesting flavor combination will encourage a woman to buy to a greater extent.

In stage II, 386 correctly completed questionnaire forms were analyzed. Correctly completed questionnaires were obtained from 84 men and 302 women (78.24% and 21.76%, respectively). Respondents aged 21-30 dominated both among women and men. Men declared a higher income (26.19% of respondents with an income above 5,000 pln) compared to women (46.36% of women declared an income of 1,000-2,999 pln). The respondents lived mainly in cities with more than 500,000 inhabitants. In the questionnaire from stage II, one of the characteristics of the studied population was the type of diet used. Vegetarian and vegan diets were marked by 107 (27,72%) and 69 people (17,88%), respectively, while 173 people (44,82%) declared that they are currently not on any diet. Comparing this to the general data, vegetarianism is declared by about 4% of Poles (over a million people aged 18-65 do not eat meat), of which women constitute about 60% of this group, and 70% are people under 35. Vegetarianism is a broad concept of avoiding some or all animal-based foods in the diet. Due to the heterogeneous and diverse range of nutritional practices, a vegetarian diet can be divided into several varieties, like e.g. (lacto-vegetarianism, ovo-vegetarianism, lacto-ovo-vegetarianism). A more restrictive form of vegetarianism is veganism, in which no animal products are eaten, including gelatin, milk, eggs or honey. A vegan diet can be chosen for ethical (animal rights and welfare), moral, spiritual, religious, as well as social and environmental reasons related to intensive animal husbandry. People's awareness of the significant environmental impact of the food produced by consumers is also growing. One of the reasons for using a vegetarian or vegan diet is also health considerations, which may be most influenced by the public opinion regarding their benefits and the growing number of clinical and epidemiological studies. The use of plant-based diets may reduce the risk of cardiovascular disease, coronary heart disease and diabetes.

In order to achieve the assumed goals of the research, it was necessary to define the types of tofu preferred by consumers. Most of the respondents in this question marked the answer "smoked" (165 answers), as well as natural (133 answers). A significant number of the respondents chose herbs, dried tomatoes / tomatoes, and chili as an addition to tofu (236, 160 and 119 responses, respectively). Most respondents consumed tofu as an addition to main courses (248 responses), it is also often used as an addition to salads (n = 166), grilled dishes (n = 120) and sandwiches (n = 115). The questionnaire (stage II) also included a multiple-choice question, in which the respondents were asked what kind of tofu was missing on the market according to the respondents. People filling in the questionnaire had several options to choose from, the most frequently mentioned answer being "made from an ingredient other than soy" (143). Some respondents believed that there is no shortage of any kind of tofu on the market (113). Tofu consistency preferences were also examined. People filling in the form had a choice of hard tofu and silky tofu, which are the two most popular variants of this product on the Polish market (68,65% of the respondents preferred hard tofu). The majority of respondents, when buying tofu, paid attention to the price and composition (251 and 202, respectively), while the brand and calorific value were the least important. The majority of respondents bought tofu in a supermarket / hypermarket (n = 310 people), 47 respondents bought tofu in health food stores, and only 10 in local stores. Buying tofu in online stores declared 7 people. One of the concepts selected for the study was to create a product in a sweet-flavored version, therefore the respondents were asked an open question: "Would you like to try a sweet version of tofu? If so, in what flavor variants?". This question was not obligatory and was completed by 277 people (71.76%), of which the respondents could give several flavor variants, which were then summarized. A negative attitude to the topic ("no", "rather not", "probably not") was expressed by 89 people; 18 people wanted to try this type of tofu (without giving examples), while three respondents were unable to respond to this question. The rest of the respondents suggested specific flavor versions. Based on the information collected (the results from stage I and II and literature review) an experiment plan was prepared to determine the appropriate technological parameters to maximize the objective function, for which the yield of tofu was assumed (stage III). The production of tofu was divided into two stages: preparation of milk from seeds, from which tofu was produced in the next stage. The milk production process started with the grinding of grains with the addition of an appropriate amount of water, which was then filtered through a cotton cheese cloth. The prepared suspension was boiled and kept at a suitable temperature in order to activate the proteins, and then cooled to the temperature adjusted to the used coagulant. The coagulant dissolved in water was added to the milk, mixed gently and then

cooled. It was then filtered with flexible polyethylene cheesecloths. The whey obtained was poured out and the resulting curd was placed in a tofu mold form with sterile gauze. The final step was pressing under pressure to obtain the desired shape. Based on the data available in the literature, the maximum and minimum values of technological parameters were determined, and then trial batches for soybean and hemp tofu were prepared. The effect of the addition of the coagulant on the performance was also verified. As in the process of producing soy and hemp tofu, such coagulants as citric acid, magnesium sulfate, magnesium chloride, calcium chloride were checked. From an economic and technological point of view, efficiency is the most important process parameter, therefore it must be as high as possible, but it must not lower other quality characteristics of the product. There is little information in the literature regarding hemp tofu research, so sources on the production of soybean tofu were used to identify factors affecting the quality of this product. After developing the recipe for natural hemp tofu, an attempt was made to prepare the different versions. Production efficiency data is available in the literature, depending on the raw materials, methods and parameters used (e.g. the yield of soy tofu made from 100 g of seeds with the addition of lupine ranged from 140 to 170 g of tofu, but this value decreased with increasing its addition). Consumers instinctively prefer sweet tastes, which are treated as a source of energy. Likewise, there are socio-cultural factors in favor of sweet taste, as even as children we receive sweets as a reward for good behavior. On the other hand, people avoid sour and bitter tastes, associated with toxicity and danger.

The highest protein content (20,41%), was obtained in the natural variant with salt. The natural version, compared to this type of hemp tofu equivalents available on the market (Pro Soya - 12.4%, Look Food - 17.3%), was characterized by a higher protein content. The ions contained in the salt, i.e. Na^+ and Cl^- , could have influenced the highest protein content in tofu in the natural version with salt, because individual cations and anions may affect the protein content in the prepared soy or hemp milk, and SO_4^{2-} has a greater possibility of salting out compared to Cl^- . The protein content of tofu may vary depending on the factors that occur during the production process, such as the amount and type of coagulant, as well as the temperature of its addition. The discrepancy in the protein content of soybean tofu reported in the literature is quite significant, and the values obtained in this study are at a fairly high level. This is important in terms of introducing a new product to the market as high-protein foods for health and appearance consumers are becoming one of the fastest growing product categories. The importance of the amount and source of protein in meals is particularly emphasized, with an emphasis on moving away from animal-based protein and switching to plant-based protein. Given the importance of protein in general for food consumers, this study investigated whether

nutritionally-minded consumers would be more likely to buy higher protein hemp tofu. The results of the research in stage I confirm the existence of a relationship between the high assessment of the importance of nutritional values and the probability of purchasing tofu containing higher amounts of protein, which was recorded at the significance level. Summarizing, hypothesis H7. (consumers who attach great importance to nutritional value and are more likely to buy hemp tofu containing higher amounts of protein). has been positively verified. In the study by Banovic et al. (2018), when asked about combinations with plant-based products with increased protein content, consumers mentioned tofu, but products such as yoghurts, breads and breakfast cereals appeared more often. The main factors discouraging the consumption of legume proteins, such as soy, are: unethical production, causing health problems (allergies), lack of health-promoting properties and unfavorable sensory properties affecting the taste of the product. Taking this into account, hemp tofu could be a good alternative to overcome these barriers.

The content of saturated fatty acids was shaped in proportion to the percentage of total fat. Presented obtained fat results are much higher than in the products available on the market (Pro Soya 18,93% and Look Food 19,3%). Actions can be taken to reduce the amount of fatty acids (e.g. checking whether the seed germination process will reduce the fat content). It is worth suggesting this product to people on a ketogenic diet, in which fat consumption may be around 70%. The literature provides information about the different fat levels of tofu in soy tofu prepared with the addition of various amounts of lupine, the fat content ranged from 19,43% with the highest percentage of lupine to 28,41% without this additive. In other studies these values were 13,40% for the highest content of lupine and 29,2% for the lowest. Also content of fatty acids in tofu produced from different soybean varieties showed significant differences depending on the variants used, with the average content being 31,32%.

Consumer preferences for food products may depend on a successful combination of taste, texture, smell and appearance, therefore sensory evaluation is an integral part of product development. Aspects such as the color and shape of food can also influence the perception of taste, aroma and texture. Researches are also conducted on the use of natural coagulants, which may influence on the organoleptic evaluation of the obtained product. The addition of 1% black garlic extract improved the qualitative and sensory properties of tofu, while the tofu with the addition of rosemary, lavender and thyme received worse assessments of colour, smell and overall acceptability compared to the control sample. Using apple juice "Tsugaru" like a coagulant, improved the sensory and antioxidant properties, which resulted in an increase in the quality of the tested product. Used apricot juice to produce tofu showed that tofu with a 2%

addition of this juice achieved good overall acceptability. Tofu acid whey is also used as a natural coagulant, and the product produced in this way is better assessed organoleptically due to its slightly sweetish taste and good texture.

As part of this study, a cost analysis was carried out, which helped to estimate the cost of producing a new variants on a laboratory scale, taking into account only the price of raw materials. Several limitations were noticed when conducting the research in this study. One of the key factors was to reach the group of respondents consuming tofu. It was assumed that the largest group of consumers are vegans and vegetarians, they are still quite specific groups, despite the rapidly growing market for this type of food. Another limitation was the poor knowledge of hemp tofu by consumers and also differences in the perception of sweetness by individual consumers. As was shown, this feeling may vary depending on, for example, gender. The conducted research was based only on a laboratory scale, and in the case of larger-scale application and implementation, technological and quality problems should be expected, because the scale of the process can significantly affect the final quality of the tofu. Due to the fact that the quality of the final product is also influenced by the packaging technology, attention should be paid to the effectiveness of the packaging method used (vacuum packaging machine), especially that a product spoilage may occur. Storage tests should also be carried out to determine the use-by date of the produced tofu. These types of products contain significant amounts of water and protein, which makes them prone to microbial growth, especially if the procedures for their production and storage are not followed.

Based on the analysis of literature data, empirical material obtained in surveys, market analysis, physico-chemical analyzes and sensory evaluation, drawn some statements and conclusions. The hemp version of tofu is not widely known among soy tofu consumers, and people who consume soy tofu approve of the use of hemp seeds in food products. Consumers showed a more positive attitude towards hemp tofu than towards soy tofu. Women declared more frequent consumption of tofu than men ($p > 0,05$). Tofu is consumed more often by people with a lower average monthly income ($p < 0,05$) and these people declared a higher probability of buying hemp tofu when there is a promotion in the store ($p < 0,05$). The greatest motivation for buying hemp tofu by people who consume soy tofu will be recommendation by friends, which has a greater impact on the likelihood of purchase for women ($p < 0,05$). On the other hand, the packaging containing the information "GMO-free" will encourage people to buy to the smallest extent, with a higher probability of purchasing being declared by people with lower level of education ($p < 0,05$). The obtained hemp tofu contained higher amounts of protein compared to the products on the market, and consumers who attach great importance to the

protein content of the products are more likely to buy hemp tofu containing higher amounts of this ingredient. Consumers looking for variety on the tofu market showed an interest in new raw materials. The manufactured product in a new versions having the greatest potential as it received a high rating in an organoleptic panel. Therefore, it can be assumed that the appearance of this type of product on the market could attract the interest of consumers. However, further research should be carried out related to the improvement of specific versions, optimization of nutritional values and the use of natural coagulants. The use of natural coagulants will allow for a more positive perception of the product by consumers, so it would be advisable to select a group of natural coagulants and investigate how their addition affects the efficiency, nutritional value and organoleptic evaluation. The appropriate selection of the coagulant is quite important because it can significantly affect the evaluation of the entire product.

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