



Preferences of consumption of selected plant-based drinks

Preferencje dotyczące spożywania wybranych napojów roślinnych

Anna Klaudia Szczyrba^{1,A-F}✉, Izabela Kawulok^{1,A-B,D}, Agnieszka Bielaszka^{2,E-F}

¹ Students' Research Club at the Department of Food Technology and Quality Evaluation, Department of Dietetics, Faculty of Public Health in Bytom, Medical University of Silesia in Katowice, Bytom, Poland

² Department of Food Technology and Quality Evaluation, Department of Dietetics, Faculty of Public Health in Bytom, Medical University of Silesia in Katowice, Bytom, Poland

A – Research concept and design, B – Collection and/or assembly of data, C – Data analysis and interpretation, D – Writing the article, E – Critical revision of the article, F – Final approval of the article

Szczyrba AK, Kawulok I, Bielaszka A. Preferences of consumption of selected plant-based drinks. Med Og Nauk Zdr. doi: 10.26444/monz/169965

Abstract

Introduction and Objective. Plant-based cow's milk substitutes are used, among others, in cases of allergies or intolerance to the ingredients contained in milk, resignation from animal products, or in the case of certain diseases (e.g. hypocholesterolaemia). The most important factors taken into account by consumers when choosing a plant-based drink are the sensory characteristics that attest to the quality of the food product. The aim of the study was a sensory evaluation of the most popular plant-based drinks, as well as the analysis of the reasons for their choice, and the frequency of consumption among students of dietetics at the Medical University of Silesia in Katowice, south-west Poland.

Materials and method. The study was conducted using an original, anonymous questionnaire, in which 109 students participated. A sensory analysis of 5 plant-based drinks was also carried out in terms of taste, aroma, consistency and colour.

Results. It was shown that more than half of the respondents (56%; n=61) included plant-based drinks in their diet. Only the gender of the respondents ($p=0.047$) significantly affected the consumption of drinks – women more willingly than men – to drink plant-based drinks. The surveyed students most willingly choose the oat drink among plant-based drinks – 54.1% (n=33). The most common reason for choosing plant-based drinks was the fact that they are an interesting alternative to cow's milk – 52.5% (n=32). In sensory evaluation, oat drink was definitely the best-rated drink.

Conclusions. Analysis showed that physical activity significantly influenced the frequency of consumption of plant-based drinks by students. Women more often than men consume plant-based drinks and were more likely to check their composition. The composition of the drinks was more often checked by students in the final year of study in relation to students in earlier years of study.

Key words

students, physical activity, sensory evaluation, drinks, plant-based drinks

Streszczenie

Wprowadzenie i cel pracy. Roślinne substytuty mleka krowiego stosuje się m.in. w przypadku alergii lub nietolerancji na składniki zawarte w mleku, rezygnacji z produktów spożywczych pochodzenia zwierzęcego czy w przypadku niektórych schorzeń (np. hipocholesterolemii). Najważniejszymi czynnikami brany pod uwagę przez konsumentów przy wyborze napoju roślinnego są cechy sensoryczne świadczące o jakości tego produktu spożywczego. Celem pracy była ocena sensoryczna najpopularniejszych napojów roślinnych, a także analiza przyczyn ich wyboru i częstotliwości spożywania przez studentów dietetyki Śląskiego Uniwersytetu Medycznego w Katowicach.

Materiał i metody. Badanie, którym objęto 109 studentów, przeprowadzono za pomocą autorskiego anonimowego kwestionariusza ankiety. Dokonano również analizy sensorycznej 5 napojów roślinnych pod kątem smaku, zapachu, konsystencji i barwy.

Wyniki. Wykazano, że ponad połowa badanych (56%; n=61) uwzględniła w swojej diecie napoje pochodzenia roślinnego. Jedynie płeć badanych ($p=0,047$) istotnie wpływa na spożycie napojów – kobiety chętniej niż mężczyźni piją napoje roślinne. Ankietowani studenci spośród napojów roślinnych najchętniej wybierają napój owsiany – 54,1% (n=33). Najczęstszym powodem wyboru napojów roślinnych jest to, że stanowią one ciekawą alternatywę dla mleka krowiego – takiego zdania jest 52,5% ankietowanych (n=32). W ocenie sensorycznej zdecydowanie najwyżej oceniono napój owsiany.

Wnioski. Z przeprowadzonej analizy wynika, że aktywność fizyczna istotnie wpływa na częstotliwość spożywania napojów roślinnych przez studentów. Kobiety częściej niż mężczyźni piją napoje roślinne i częściej sprawdzają ich skład. Skład napojów częściej sprawdzają studenci ostatniego roku studiów niż studenci lat wcześniejszych.

Słowa kluczowe

studenci, aktywność fizyczna, napoje, ocena sensoryczna, napoje roślinne

✉ Address for correspondence: Anna Klaudia Szczyrba, Students' Research Club at the Department of Food Technology and Quality Evaluation, Department of Dietetics, Faculty of Public Health in Bytom, Medical University of Silesia in Katowice, Piekarska 18, 41-902 Bytom, Poland
E-mail: anna.szczyrba.09@gmail.com

Received: 26.03.2023; accepted: 24.07.2023; first published: 07.08.2023

INTRODUCTION

Plant-based drinks are more and more often a type of products available on store shelves, both in Poland and worldwide. They are widely recognized as cow's milk substitutes in the event of allergies or intolerances to ingredients in animal milk, and the abandonment of animal products for ethical, environmental, or other reasons. The market for plant-based drinks is systematically developing, new types of products are appearing, including produced from new raw materials produced in an ecological way, or additionally enriched with minerals and vitamins (e.g. in vitamin D, which is not naturally present in food of plant origin). Moreover, these products may have various flavours (e.g. chocolate flavour) [1–4].

Plant-based drinks can be obtained from various raw materials of plant origin: cereals, pseudocereals, legume seeds, seeds, nuts, hemp or chestnuts. The most commonly used for the production of drinks are: soy, oats, almonds, rice and coconut [1–3, 5]. Depending on the raw material, the drinks will differ in nutritional values, i.e. the content of protein, fats, minerals or energy value. Most drinks have a lower or similar caloric value compared to cow's milk. The fat content, especially of saturated fatty acids, is lower than that of animal milk, while the amount of unsaturated fatty acids is higher [2, 4]. In the case of protein, only soy drinks have a value similar to cow's milk, and the rest provide two or even three times less protein [4, 6].

Moreover, plant-based drinks will be characterized by the presence of trace or larger amounts of dietary fibre in their composition, depending on the raw material or the enrichment of the food product [7]. There are also differences in the mineral and vitamin composition; cow's milk is richer in compounds such as calcium or B vitamins, where its plant substitutes either do not contain them at all or are only trace amounts, unless plant-based drinks are deliberately enriched with them. In this aspect, the bioavailability of micronutrients is important which in plant substitutes is hampered, for example, by the possibility of binding with anti-nutritional compounds of food (e.g. tannins) [7, 8].

Due to the wide range of plant-based drinks available on store shelves (e.g. flavoured, unsweetened, low-fat versions), and thus the different compositions of these products, it is important to be familiar with the label before buying. Careful reading of the information on the packaging will allow selection of the most beneficial product, taking into account the individual needs of a given consumer. The most important factors taken into account by consumers when choosing food products are sensory features (such as taste, smell, texture or colour of the product), which testify to the quality of the food product, and also affect perception and sensory acceptability [4, 9, 10, 11].

Due to their characteristic properties (e.g. texture, taste), dairy products are difficult to reproduce in a substitute version. This aspect is problematic for producers, as the inept creation of the substitute will result in the lack of sensory acceptance by consumers. Reduced sensory quality is the main obstacle in the adoption of animal milk substitutes, although other determinants (such as socio-demographic factors, including the level of education and knowledge about health) and 'picky' eating behaviour (nutritional neophobia) also have an impact. On the basis of a few scientific studies, a tendency can also be observed of a stronger acceptance of

plant-based drinks which in taste most reflect the taste of animal milk [5, 10, 12].

OBJECTIVE

The aim of the study is a sensory evaluation of the most popular plant-based drinks available on the Polish market, as well as an analysis of the reasons for their selection and the frequency of consumption among students of dietetics at the Medical University of Silesia in Katowice, south-west Poland.

MATERIALS AND METHOD

An original, anonymous survey was conducted consisting of 19 questions, divided into 3 parts: respondent data, e.g. gender or year of study (7 questions), eating habits (10 questions), and sensory evaluation (2 questions). A total of 109 dietetics students (100 women – 91.7%; 9 men – 8.3%) from Medical University of Silesia in Katowice participated. The study group consisted of 1st year students of the 1st cycle – 56.0% (n=61), 1st year of the 2nd cycle – 36.7% (n=40) and 2nd year of the 2nd cycle – 7.3% (n=8). The age range of the respondents was categorized into 3 age groups: 18–20 years old, 21–25 years old and 26–30 years old. The above-mentioned age groups included respectively 27.5% (n=30), 48.6% (n=53) and 23.9% (n=26) of the respondents, of whom 80.7% (n=88) live in the city, and the remaining 19.3% (n=21) in the countryside.

For each interviewed student, the body mass index BMI (kg / m²) was calculated based on his / her height and body weight. The values regarding height and weight were declared by the respondents. According to the interpretation by the WHO [13], most of the respondents had normal body weight – 80.7% (n=88), and 11.9% had body weight deficiency (n=13), 5.5% – overweight people (n=6), and 1.8% – with obesity of the 1st class (n=2).

The survey and sensory evaluation of plant-based drinks was carried out in March 2022. The sensory evaluation took place in the sensory laboratory of the Department of Dietetics of the Medical University of Silesia in Katowice, meeting the PN-EN ISO 8589: 2010 standards. The ranking method to establish preferences was performed according to ISO 8587:2006. The research material consisted of the 5 most popular plant-based drinks available on the Polish market. Samples were served at room temperature in specially prepared and coded glasses. Plant-based drink samples were coded: 105 – soy drink, 205 – oat drink, 305 – coconut drink, 405 – almond drink, 505 – rice drink. In order to neutralize the taste, water, also at room temperature, was used between samples. The task of the evaluators was to rank the samples from the least to the most preferred by the students in terms of taste, aroma, colour and consistency.

Statistical analysis and calculations were performed using the following programmes: Excel and Statistica 13.0, Stat Soft Polska. Measurable data was characterized using descriptive statistics, while non-measurable data were characterized by using multi-way Tables. Statistical significance was determined at the level of $p < 0.05$.

RESULTS

More than half of the respondents (56%; n=61) included plant-based drinks in their diet, most often bought in shops or supermarkets. Only the gender of the respondents (p=0.047) significantly influenced the consumption of drinks – women were more likely to drink plant-based drinks than men. The other predictors, i.e. age, BMI, place of residence, physical activity and year of study, were not statistically significant (Tab. 1).

Table 1. One-dimensional significance tests for the consumption of plant-based drinks

Effect	SS	df	MS	F	p
Free word	21	1	21.90	101.5	10 ⁻⁶
Gender	0	1	0.87	4.0	0.047026
Age	1	2	0.65	3.0	0.052769
BMI	0	3	0.32	1.5	0.228576
Place of residence	0	1	0.13	0.6	0.447233
Physical activity	1	3	0.40	1.9	0.140383
Year of study	1	2	0.65	3.0	0.052937
Error	20	96	0.22		

SS – Sum of Squares; df – Degrees of Freedom; MS – Mean Square; F – F-Snedecor test; p – materiality level

The surveyed students most willingly choose the oat drink – 54.1% (n=33) and the almond drink – 42.6% (n=26) among plant-based drinks. The least preferred drink, on the other hand, was rice drink, which was indicated by only 8.2% (n=5) of students as being the least frequently consumed (Fig. 1). The main reason for reaching for a specific plant-based drink is its ‘better taste’ – 80.3% (n=49), and the least important reason, ‘taste similar to cow’s milk’ – 8.2% (n=5). Only one person – 1.6% (n=1) prepared plant-based drinks at home, and consumed a specific type of drink most often due to the ease of preparation (answer ‘other’) (Fig. 2).

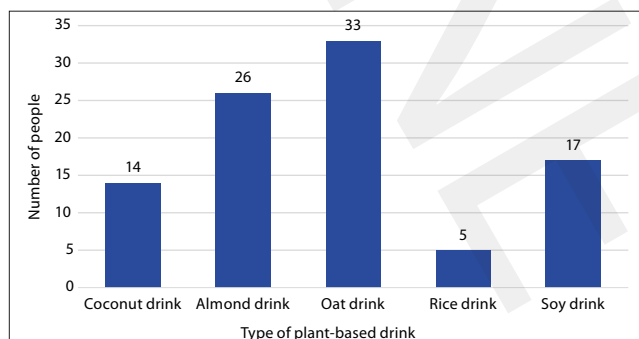


Figure 1. Most frequently consumed types of plant-based drinks [N=61]

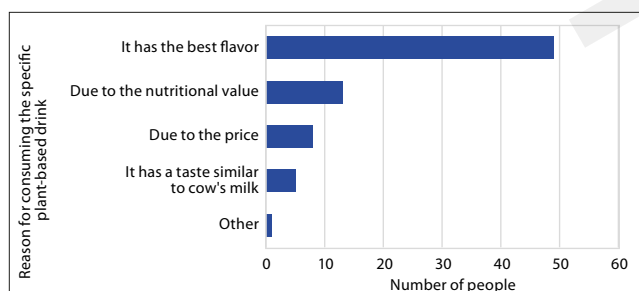


Figure 2. Reason for consumption of a specific plant-based drink [N=61]

The respondents who consumed plant-based drinks most often used them for coffee – 70.5% (n=43) and for breakfast cereals – 60.7% (n=37), and least often for making waffles – 3.3% (n=2). One respondent indicated cocktails in the answer ‘other’, which is 1.6% of respondents consuming plant-based drinks (n=1) (Fig. 3).

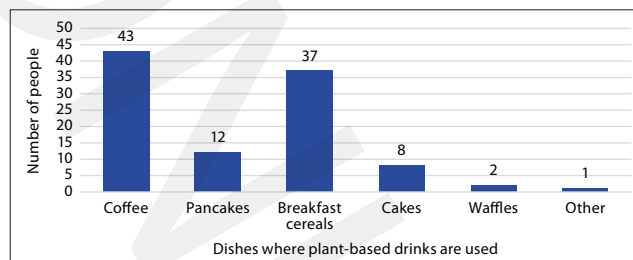


Figure 3. Most common use of plant-based drinks by respondents [N=61]

Students most eagerly reached for plant-based drinks because they are an interesting alternative to cow’s milk – 52.5% (n=32). These drinks are also eagerly chosen due to the curiosity about new flavours – 26.2% (n=16), and also because the respondents like them – 24.6% (n=15). The rarest reasons for reaching for this type of drinks were: caring for the environment, lower calorific value, allergy to cow’s milk proteins and not consuming cow’s milk. Each of these reasons only received one answer. None of the respondents consumed plant-based drinks due to their popularity (Fig. 4).

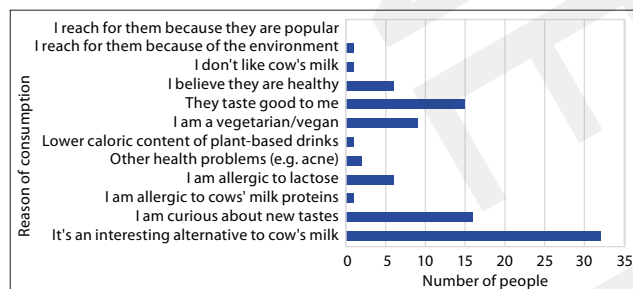


Figure 4. Reasons for consumption of plant-based drinks [N=61]

In the case of people who do not consume this type of drinks, the main reason for not including them in their diet was the lack of such a need – 72.9% (n=35). In turn, difficulty in the availability of this type of product was indicated by the smallest number of respondents – 4.2% (n=2) (Fig. 5).

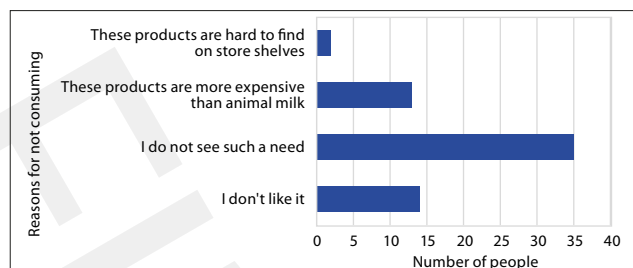


Figure 5. Reasons for the lack of consumption of plant-based drinks [N=48]

Plant-based drinks are consumed by the dietetics students most often several times a week – 17.4% (n=19) (Fig. 6). The frequency of consumption was significantly influenced only by the physical activity of the respondents (p = 0.047). Those who did not engage in physical activity usually did

not consume plant-based drinks, and the frequency of their consumption increased with increasing activity (physical activity: 1–2 times a week, 3–4 times a week). However, in the group of students who engaged in physical activity at least 5 times a week, the frequency of consumption of this type of drinks was lower. The other examined factors did not have a statistically significant impact on the frequency of consumption of plant-based drinks (Tab. 2, Fig. 7).

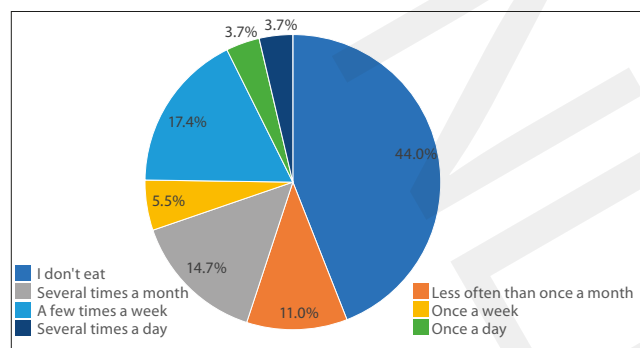


Figure 6. Frequency of consumption of plant-based drinks in the study group -% [N=109]

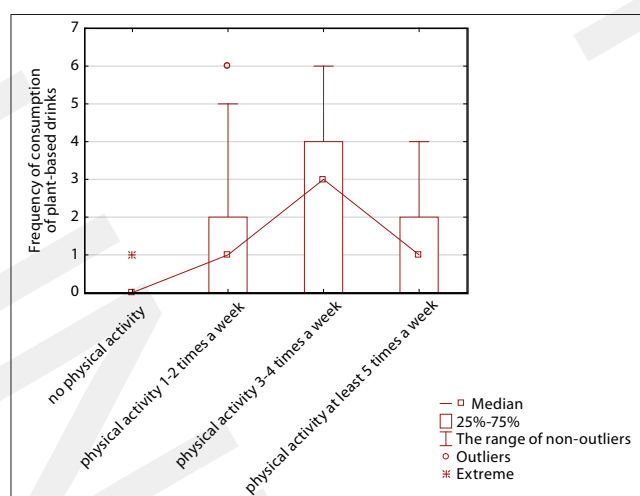


Figure 7. Box plot (box-whiskers) of the frequency of consumption of plant-based drinks depending on the physical activity of the respondents

The gender ($p = 0.015$) and the year of study of the respondents ($p = 0.028$) had a statistically significant influence on paying attention to the composition of plant-based drinks.

Table 2. One-dimensional significance tests for the frequency of consumption of plant-based drinks

Effect	SS	df	MS	F	p
Free word	6	1	6.91	2.3	0.132627
Gender	5	1	5.51	1.8	0.178907
Age	4	2	2.35	0.8	0.459572
BMI	15	3	5.27	1.8	0.161142
Place of residence	2	1	2.37	0.8	0.376522
Physical activity	24	3	8.23	2.7	0.047473
Year of study	4	2	2.28	0.8	0.471055
Error	288	96	3.00		

SS – Sum of Squares; df – Degrees of Freedom; MS – Mean Square; F – F-Snedecor test; p – materiality level

Women who consumed plant-based drinks were more likely to check the composition of the drink than men. The higher the education, the more the students paid attention to the composition of these food products. The other predictors were not statistically significant for paying attention to the composition of plant-based drinks (Tab. 3).

Table 3. One-dimensional significance tests for paying attention to the composition of plant-based drinks

Effect	SS	df	MS	F	p
Free word	6	1	5.58	8.1	0.005429
Gender	4	1	4.21	6.1	0.015258
Age	3	2	1.32	1.9	0.152754
BMI	3	3	0.94	1.4	0.258968
Place of residence	0	1	0.06	0.1	0.764559
Physical activity	4	3	1.41	2.0	0.112912
Year of study	5	2	2.56	3.7	0.028087
Error	66	96	0.69		

SS – Sum of Squares; df – Degrees of Freedom; MS – Mean Square; F – F-Snedecor test; p – materiality level

Variation of the resulting subjective sensory assessment of drinks depended on the type of drink (the 'drink' factor) and other uncontrolled factors, e.g. the influence of individual evaluation of taste, colour, aroma or consistency (Fig. 8). The influence of the type of drink ($MS = 10.124$) exceeded by many times ($F = 12.561$) the influence of uncontrolled factors ($MS = 0.806$). The significance rating ($p < 10^{-6}$) showed that the drinks vary significantly (Table 4). Assessment of homogeneous groups in the Tukey HSD test showed that there were 3 distinct but overlapping groups: the worst rated drinks (sample codes 305, 405, 505), medium rated drinks (105 and 405), and the highest rated drinks (codes 105 and 205). Due to the significant influence of uncontrolled factors and the inevitable influence of the subjective opinion, there were group overlaps, i.e. drinks were simultaneously assigned to 2 different groups. The most preferred drinks were definitely drink 205 and, unfortunately, with greater uncertainty, drink 105, while the least preferred drinks were definitely drink 305, and drinks 505 and 405 with greater uncertainty (Tab. 5).

Table 4. One-dimensional significance tests in the sensory evaluation of plant-based drinks

Effect	SS	df	MS	F	p
Free word	4905	1	4905.00	6085.4	$< 10^{-6}$
Drink	40	4	10.12	12.6	$< 10^{-6}$
Error	435	540	0.81		

(Rounding in accordance with ISO 80000-1 annex B). SS – Sum of Squares; df – Degrees of Freedom;

MS – Mean Square; F – F-Snedecor test; p – materiality level

Taking into account the individual factors in the sensory evaluation, in terms of taste, the most willingly preferred plant-based drink was the drink with sample code 505, in terms of smell – sample code 305, and in terms of consistency and colour – 205. In turn, the least preferred drinks were: in terms of taste – 405, consistency – 305, smell and colour – 505 (Tab. 6).

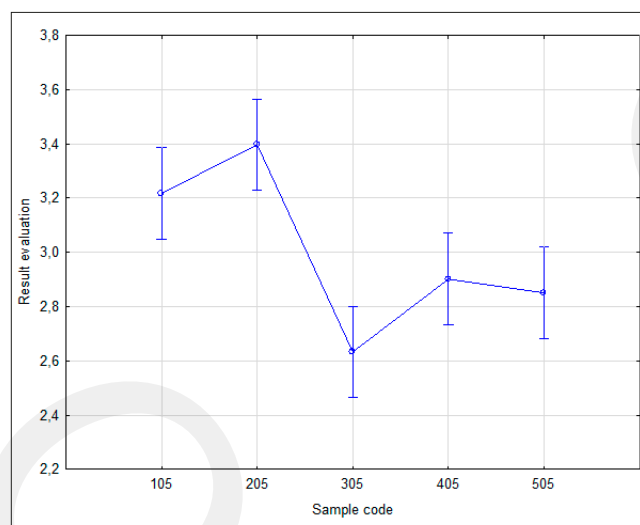


Figure 8. Estimated marginal means in sensory evaluation of plant-based drinks. The sample codes are in the methodology section

Table 5. HSD Tukey's test – result evaluation in sensory evaluation of plant-based drinks

Sample code	Result evaluation Average	Worst rated	Rated at an average level	Top rated
305	2.63	****		
505	2.85	****		
405	2.90	****	****	
105	3.22		****	****
205	3.40			****

The sample codes are in the methodology section

DISCUSSION

The production and consumption of plant-based drinks worldwide has been systematically increasing in recent years, and the use of innovative technologies allows, among other things, expansion of the range of substitutes for animal milk. In 2015, the availability of these products in stores in Europe increased by 9% (reaching USD 1.9 billion with sales of 138 different variants of drinks), while in Brazil in 2018 the consumption of plant-based drinks increased by 51.5%. It is predicted that by 2024 the market of plant-based drinks will achieve revenues in excess of USD 38 million [14, 15].

In a study by Rincon et al. [15], 40% of the respondents stated that they rarely consumed plant-based drinks, and 13% declared that they had never drunk plant-based drinks. Only 28% of the respondents consumed cow's milk substitutes frequently. However, in the own study, 44% of respondents did not consume plant-based drinks at all, and 30% consumed them often (once a week or more). Women drank plant-based drinks much more often than men (Tab. 1). This is confirmed by the study by Islam et al. [16], in which 43.6% of people consuming these products were men and 56.4% were women.

People who regularly consume cow's milk substitutes usually have their most preferred drinks, which they choose for various reasons. In the current study, oat drink was by far the most frequently chosen drink, followed by almond drink (Fig. 1). Similarly, in the study by Wolf et al. [17], the almond drink was consumed most frequently by the respondents. In

Table 6. Single sensory evaluation of plant-based drinks

Sample code	Sum of ranks	Order of ranks	Mean values of ranks	Standard deviation	Standard deviation of the rank mean value
Taste					
105	380	IV	3.49	1.26	0.12
205	358	III	3.28	1.31	0.13
305	270	II	2.48	1.14	0.11
405	239	I	2.19	1.43	0.14
505	388	V	3.56	1.36	0.13
Aroma					
105	312	II	2.86	1.27	0.12
205	335	IV	3.07	1.31	0.13
305	352	V	3.23	1.50	0.14
405	331	III	3.04	1.43	0.14
505	305	I	2.80	1.53	0.15
Consistency					
105	358	IV	3.28	1.07	0.10
205	412	V	3.78	1.43	0.14
305	256	I	2.35	1.31	0.13
405	328	III	3.01	1.24	0.12
505	281	II	2.58	1.54	0.15
Colour					
105	353	III	3.24	1.10	0.11
205	376	V	3.45	1.57	0.15
305	270	II	2.48	1.36	0.13
405	367	IV	3.37	1.14	0.11
505	269	I	2.47	1.51	0.14

The sample codes are in the methodology section

the current study, the respondents consumed plant-based drinks most often as an addition to coffee and breakfast cereals (Fig. 3). Similarly, in the study by Haas et al. [18], consumption was reported by respondents whose households were also plant-based. Those with a plant-based diet preferred plant-based drinks with their cereals and smoothies.

The consumption motives are also influenced by many factors. As the reason for consuming plant-based drinks, the respondents in our own study most often answered that they are an interesting alternative to cow's milk, and that they are curious about new flavours. A similar dependence was observed in the study by Adamczyk et al. [19], where the respondents mainly choose plant-based drinks due to curiosity about the taste, the desire to diversify their diet, and the need to take care of their health.

On the other hand, in a study by Haas et al. [18], environmental and ethical issues were the main motives for the consumption of milk substitutes. People who do not consume plant-based drinks mainly mention the lack of such a need and the disliking the taste of these products (Fig. 5). Similar results were obtained in the study by Adamczyk et al. [19], in which the respondents stated that they did not use these products due to their high price, but also due to the lack of acceptance of the taste of the substitutes. It follows that taste is an important aspect of consumer choice of products, as they do not consume food which is not to their liking.

The sensory evaluation of plant-based drinks is a very subjective test, therefore the results vary widely. For example, in the current study, oat drink (sample code 205) was

by far the most preferred drink (Fig. 8), while in the study by Yao et al. [20] it obtained the lowest result among the respondents as the least preferred drink. On the other hand, similar results concerned the soy drink. In our own study, this drink was classified in second place, as in the study by Yao et al. Also, the evaluation of individual components that make up the overall sensory evaluation (e.g. taste, smell) of drinks may vary.

Sokulski et al. [21], who are also at the same time pioneers in the sensory evaluation of plant-based drinks, in their study compared milk imitations obtained from various protein isolates derived from legume seeds, and showed that they were colouristically and consistently similar to cow's milk (which indicates sensory acceptance). Unfortunately, such products showed a lack of taste and smell. Among the tested milk substitutes, the one containing broad bean isolate was the worst-rated product in the sensory evaluation, and the isolates from lima, mung and peas were those that were top-rated. The soy drink was rated relatively low in sensory evaluation. In the own study comparing plant-based drinks obtained from different raw materials, the soy drink (sample code 105; single sensory evaluation of the drinks) was assessed well in terms of taste and consistency, average in terms of colour, and poor in terms of smell (Tab. 6). Research by Frühauf et al. [22] shows that the soy drink showed the highest degree of acceptability in terms of taste, while in the own study it was coconut drink (sample code 505) (Tab. 6). Dissimilarity of sensory acceptability results, among other things, from cultural differences and the place of residence, e.g. the characteristic bean flavour of soy milk is appreciated and important for Asians ('traditional' consumers). Of course, the individual taste preferences of the individual also have to be taken into account [23].

CONCLUSIONS

Analysis of the research conducted among students of dietetics at the Medical University of Silesia in Katowice allows for the following conclusions:

- 1) among the surveyed students studying dietetics, women are more likely than men to drink plant-based drinks;
- 2) among the students who consumed plant-based drinks, women check the composition of the drink significantly more often than men, and students from the last years of studies compared to earlier years of studies;
- 3) physical activity had a statistically significant influence on the frequency of consumption of plant-based drinks. The frequency of consumption of plant-based drinks increases with increasing activity (from no activity to activity 3–4 times a week);
- 4) in sensory evaluation, the oat drink was by far the most preferred plant-based drink, and the coconut drink was by far the least preferred.

REFERENCES

1. Walczak Z, Florowska A, Krygier K. Napoje roślinne mlekopodobne - charakterystyka i analiza dostępności w Polsce. *Przemysł Spożywczy*. 2017;71(10):14–18. <https://doi.org/10.15199/65.2017.10.3>
2. Stobiecka M, Wajs J. Roślinne substytuty produktów mlecznych najczęściej dostępne na rynku krajowym. *Przemysł Spożywczy*. 2019;10(73):46–50. <https://doi.org/10.15199/65.2019.10.7>
3. Hozyasz KK, Słowik M. Mleka inne niż ogólnodostępne krowie – argumenty za i przeciw. *Prz Gastroenterol*. 2013;8(2):98–107. <https://doi.org/10.5114/pg.2013.34835>
4. Hoffmann M, Kostyra E. Jakość sensoryczna i wartość odżywcza węgańskich substytutów mleka krowiego. *Postępy Techniki Przetwórstwa Spożywczego*. 2015;1:52–57.
5. Giacalone D, Clausen MP, Jaeger SR. Understanding barriers to consumption of plant-based foods and beverages: insights from sensory and consumer science. *Curr Opin Food Sci*. 2022;48:100919. <https://doi.org/10.1016/j.cofs.2022.100919>
6. Pogoń P, Pogoń K, Jaworska G, et al. Soja jako surowiec do produkcji mleczek roślinnych o właściwościach prozdrowotnych. In: *Zagadnienia aktualnie poruszane przez młodych naukowców 7*, Kuczera M, editor, Piech K. Kraków: CREATIVETIME; 2016. p. 107–111.
7. Escobar-Sáez D, Montero-Jiménez L, García-Herrera P, et al. Plant-based drinks for vegetarian or vegan toddlers: Nutritional evaluation of commercial products, and review of health benefits and potential concerns. *Int Food Res J*. 2022;60:111646. <https://doi.org/10.1016/j.foodres.2022.111646>
8. Singh-Povel CM, van Gool MP, Rojas APG, et al. Nutritional content, protein quantity, protein quality and carbon footprint of plant-based drinks and semi-skimmed milk in the Netherlands and Europe. *Public Health Nutr*. 2022;25(5):1416–1426. <https://doi.org/10.1017/S1368980022000453>
9. Grębowiec M. Jakość jako determinanta budowania pozycji konkurencyjnej na rynku produktów żywnościowych. Warszawa: Wydawnictwo SGGW; 2021.
10. Pointke M, Ohlau M, Risius A, et al. Plant-based only: investigating consumers, sensory perception, motivation, and knowledge of different plant-based alternative products on the market. *Foods*. 2022;11:2339. <https://doi.org/10.3390/foods11152339>
11. Angelino D, Rosi A, Vici G, et al. Nutritional quality of plant-based drinks sold in Italy: The Food Labelling of Italian Products (FLIP) study. *Foods*. 2020;9(5):682. <https://doi.org/10.3390/foods9050682>
12. Pointke M, Albrecht EH, Geburt K, et al. A comparative analysis of plant-based milk alternatives Part 1: Composition, sensory, and nutritional value. *Sustainability*. 2022;14:7996. <https://doi.org/10.3390/su14137996>
13. <https://www.who.int/europe/news-room/fact-sheets/item/a-healthy-lifestyle---who-recommendations>
14. Jeske S, Zannini E, Arendt EK. Evaluation of physicochemical and glycaemic properties of commercial plant-based milk substitutes. *Plant Foods Hum Nutr*. 2017;72(1):26–33. <https://doi.org/10.1007/s11130-016-0583-0>
15. Rincon L, Botelho RBA, de Alencar ER. Development of novel plant-based milk based on chickpea and coconut. *LWT*. 2020;128:109479. <https://doi.org/10.1016/j.lwt.2020.109479>
16. Islam N, Shafiee M, Vatanparast H. Trends in the consumption of conventional dairy milk and plant-based beverages and their contribution to nutrient intake among Canadians. *J Hum Nutr Diet*. 2021;34(6):1022–1034. <https://doi.org/10.1111/jhn.12910>
17. Wolf CA, Malone T, McFadden BR. Beverage milk consumption patterns in the United States: Who is substituting from dairy to plant-based beverages? *J Dairy Sci*. 2020; 103(12): 11209–11217. <https://doi.org/10.3168/jds.2020-18741>
18. Haas R, Schnepps A, Pichler A, et al. Cow milk versus plant-based milk substitutes: A comparison of product image and motivational structure of consumption. *Sustainability*. 2019;11(18):5046. <https://doi.org/10.3390/su11185046>
19. Adamczyk D, Jaworska D, Affeltowicz D, et al. Plant-based dairy alternatives: consumers, perceptions, motivations, and barriers-results from a qualitative study in Poland, Germany, and France. *Nutrients*. 2022;14(10):2171. <https://doi.org/10.3390/nu14102171>
20. Yao Y, He W, Cai X, et al. Sensory, physicochemical and rheological properties of plant-based milk alternatives made from soybean, peanut, adlay, adzuki bean, oat and buckwheat. *Int J Food Sci Technol*. 2022;57(8):4868–4878. <https://doi.org/10.1111/ijfs.15814>
21. Sosulski F, Chakraborty P, Humbert ES. Legume-based imitation and blended milk products. *Can Inst Food Technol J*. 1978;11:117–123. [https://doi.org/10.1016/S0315-5463\(78\)73224-4](https://doi.org/10.1016/S0315-5463(78)73224-4)
22. Frühauf V, Egea M, Hernades T, et al. Relationship between physicochemical and sensory characteristics of commercial plant-based beverages. *J Culin Sci Technol*. 2022;1–17. <https://doi.org/10.1080/15428052.2021.2024470>
23. Yang A, Smyth H, Chaliha M, et al. Sensory quality of soy milk and tofu from soybeans lacking lipoxigenases. *Food Sci Nutr*. 2015;4(2):207–215. <https://doi.org/10.1002/fsn.3.274>