Mizera, Krzysztof Maciej, Mizera, Justyna. The effect of plant-based dietary supplements on weight reduction and the regulation of metabolism. Journal of Education, Health and Sport. 2022;12(10):265-274. eISSN 2391-8306. DOI http://dx.doi.org/10.12775/JEHS.2022.12.10.031
https://apcz.umk.pl/JEHS/article/view/39802
https://zenodo.org/record/7274204

The journal has had 40 points in Ministry of Education and Science of Poland parametric evaluation. Annex to the announcement of the Minister of Education and Science of December 21, 2021. No. 32343. Has a Journal's Unique Identifier: 201159. Scientific disciplines assigned: Physical Culture Sciences (Field of Medical sciences and health sciences); Health Sciences (Field of Medical Sciences and Health Sciences). Punkty Ministerialne z 2019 - aktualny rok 40 punktów. Załącznik do komunikatu Ministra Edukacji i Nauki z dnia 21 grudnia 2021 r. Lp. 32343. Posiada Unikatowy Identyfikator Czasopisma: 201159. Przypisane dyscypliny naukowe: Nauki o kulturze fizycznej (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu).

The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 05.09.2022. Revised: 20.10.2022. Accepted: 31.10.2022.

The effect of plant-based dietary supplements on weight reduction and the regulation of metabolism

Wpływ roślinnych suplementów diety na redukcję masy ciała oraz regulację metabolizmu

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Abstract
Introduction: As overweight and obesity have become a disease of civilization, more and more people try to accelerate weight reduction in various ways. One of the methods used is the use of dietary supplements.
Methods: 30 overweight or obese people took part in the study. At the beginning and at the end of the study, each participant was measured and weighed on a professional Tanita DC-360 body composition analyzer. The age in both groups was similar - the average was about 37 years old, height and weight in the group of men was greater. The subjects used the dietary supplement for 6 weeks. At that time, they did not take any other dietary supplements, followed the diet as before, did not consume caffeine and did not undertake any physical activity at that time.
Results: There were significant differences in the results between men and women for the field of physical. Women had a significantly higher result, which means that they were more susceptible to the effects of supplements. Individuals who achieved a weight loss score significantly higher for the field of physical.
It also turned out that although weight loss and the absence of gastrointestinal problems during supplementation were observed in both groups, they occurred in a greater amount in women than in men, and the differences these were statistically significant. Higher effectiveness among women may be the result of differences in the functioning of the endocrine system, although it is certainly worth taking a closer look at this issue. 40% of respondents did not notice any weight loss while taking supplementation.
Conclusions: Plant-based supplements reduce body weight and metabolism, and may also alleviate gastrointestinal discomfort. In addition, they improve digestion in general, increase vitality and, to a small extent, may contribute to the improvement of the immune system.

Keywords: dietary supplement, slimming, weight reduction, reduction, supplementation

Introduction
Overweight and obesity are civilization diseases that currently plague almost every highly developed country in the world. According to the data included in the Sustainable development solutions network report [1], the level of obesity among adults in Poland in 2019 was 23.1%. A higher obesity rate was found in people living in Malta, where about 28.9% of

the population suffers from obesity, or in the United Kingdom, where obesity affects 27.8% of the population. Obesity in Poland is comparable to the level of obesity in Luxembourg.

According to the World Health Organization, obesity has been classified as an epidemic of the present times, and the tendency to overeat is due to the availability of attractive food, but above all from the individual circumstances of the individual [2].

There are many causes of obesity [3], most often it is the consumption of too many calories in relation to the demand [4], but in some cases it is taking certain activities or taking substances that cause excessive dopamine release and the feeling of inadequately strong pleasure, which in turn leads to constant search for strengthening stimuli, including excessive consumption of favorite, not always healthy meals [5]. Also, the irregularity of eating contributes to excessive appetite for high-calorie products due to unfavorable fluctuations in blood glucose levels and hypoglycemic states [6,7].

In the United States of America, over $ 209 billion is spent on the treatment of obesity and its complications, which accounts for over 20% of all health care expenditure [8]. Since the effectiveness of treatment is unsatisfactory, the mechanisms responsible for excessive eating, which account for over 90% of obesity cases, are still being searched for [9]. It is also worth mentioning that while obesity can be measured by different methods, the most popular is the body mass index (BMI), which is calculated by dividing the patient's weight in kilograms by the height in meters squared. A BMI of 30 or higher indicates obesity. However, it should be realized that although BMI is a very useful initial method of obesity diagnosis, it is not particularly accurate when it comes to assessing the fat content in the human body [10]. On the other hand, this indicator may also be useful for other purposes. Epidemiological studies have shown that an increase in the body mass index (BMI) by 5 kg / m2 increases the total risk of death by 29%, the risk of death due to cardiovascular diseases by 41%, and the risk of death from diabetes by 210% [11].

Counteracting obesity is possible, it is recommended to change the beliefs and values of people regarding their physical appearance, change the eating habits of individuals, exercise and exercise more frequently, and increase health awareness [12, 13]. Despite the awareness and knowledge, people more and more often, instead of changing their eating habits or lifestyle in order to reduce body weight, people try to use dietary supplements to lose weight faster. Numerous studies show that dietary supplements with beneficial effects supporting the reduction of overweight can be used both in the treatment of obesity and its complications [14]. The use of dietary supplements is becoming more common and it is estimated that it has increased worldwide over the last 30 years [15].

However, dietary supplements are also used for other purposes, including: improving overall health (41%), maintaining health (37%), supplementing the diet (23%), preventing health problems (20%) and strengthening immunity (14%) [16]. According to data from the World Health Organization (WHO), about 80% of the adult population in developing countries use plant extracts for their health needs [17, 18].

Research methodology

Objective

The aim of the study was to determine the effect of the supplement on slimming through the use of artichoke, wild strawberry and celery extracts, the therapeutic effect of which relates to the regulation of digestive processes. On the other hand, the use of nettle is to promote the acceleration of metabolism, and tamarind support the processes of weight reduction. According to the assumption, such a combination should support the work of the liver and ultimately contribute to weight reduction.

The group of respondents and research methods

30 overweight or obese people took part in the study, these people did not play sports or took up physical activity occasionally, not more than once a week. Men constituted 33% of the total. Before starting the study, the participants were informed about the course of the study, the composition of the supplement and the fact that at any time, without giving a reason, they could resign from taking the supplement without any consequences. Both at the beginning and at the end of the study, each participant was measured and weighed on a professional Tanita DC-360 body composition analyzer. The age in both groups was similar - the average was about 37 years old, height and weight in the group of men was greater. The dispersion of height in the group of men was greater than that of women (Table 1). The body weight in the case of women shows greater deviations and is almost 15% lower than the weight of men. The subjects used the dietary supplement for 6 weeks. At that time, they did not take any other dietary supplements, followed the diet as before, did not consume caffeine and did not undertake any physical activity at that time.

Tab. 1. Characteristics of the respondents for sex, age, BMI with interpretation

Parameter		All study patients
Gender *(N, %)*	Women	20 (66,67%)
	Men	10 (33,33%)
Age [y] mean±SD		37,30 ± 5,41
BMI [kg/m^2] mean±SD		27,00 ±2,83
Interpretation BMI *(N, %)*	Standard	4 (13,33%)
	Overweight	23 (76,67%)
	Obesity I degree	1 (3,33%)
	Obesity II degree	2 (6,67%)

Note: Data are presented as number of patients or mean and standard deviation

Statistical analysis

Descriptive statistics are presented as mean (standard deviation), median (interquartile range). The Shapiro-Wilk test was utilised to verify the normality of the distribution of continuous variables. Wariables were compared using the Pearson correlation or Spearman's rank correlation. Groups were compared using Manna-Whitney`a test. All data were analysed using R software, version 3.6.3 (The R Foundation for Statistical Computing).

Results

Studies have shown that 90% of respondents consumed 4 or 5 meals a day, so it can be concluded that they consumed meals quite regularly. The mean weight reduction occurred in 18 out of 30 subjects and was on average 2.39 ± 0.68 kg. Moreover, 73% did not experience any gastrointestinal problems, and only 23% had them sporadically (Table 2).

Tab. 2. Information on the number of meals consumed, weight loss and gastrointestinal problems

Parameter		All study patients
Number of meals during the day *(N, %)*	Less than three	3 (10,00%)
	Three	5 (16,67%)
	Four/five	22 (73,33%)
Weight reduction after testing the supplement *(N, %)*	Yes mean±SD [kg]	18 (60,00%) 2,39 ± 0,68
	No	12 (40,00%)
Gastrointestinal problems *(N, %)*	Leck	22 (73,33%)
	Sometimes	7 (23,33%)
	Almost every day	1 (3,33%)

Note: Data are presented as number of patients or mean and standard deviation

Effects that were not directly related to weight regulation, but influenced better digestion, better well-being, improved immunity or accelerated metabolism, were called the "field of vitality", which included all 4 factors. In the field of vitality created, the biggest change in performance in terms of performance improvement was in better digestion, and slightly less in vitality enhancement and weight loss. For the improvement of the immune system and the acceleration of metabolism, the results were intermediate - "it is difficult to say whether there was a noticeable change". For the presented categories, all variables correlated with each other, resulting in an average correlation index at the level of r = 0.71 (Tab. 3)

Tab. 3. The results of the answers for the components of the field of vitality and the total result

Variable	Rating					
	Definitely not - 1	Probably not - 2	It's hard to say - 3	Rather yes - 4	Definitely yes - 5	M
It affects better digestion	3 (10%)	1 (3,3%)	11 (36,7%)	5 (16,7%)	10 (33,3%)	3,6
Strengthens vitality and slimming	3 (10%)	3 (10%)	10 (33,3%)	7 (23,3%)	7 (23,3%)	3,4
Improving the functioning of the immune system	1 (3,3%)	4 (13,3%)	19 (63,3%)	3 (10%)	3 (10%)	3,1
Acceleration of metabolism	4 (13,3%)	5 (16,7%)	9 (30%)	5 (16,7%)	7 (23,3%)	3,2
Total score	mean + SD = 13,30±4,19 median (Q1-Q3) = 13 (11-17)					

Note: Data are presented as number of patients or mean and standard deviation

In the "field of physical" established (fat reduction, circumference reduction, improved digestion, reduction of gastrointestinal incidents, and appetite regulation) the greatest change in results in improving digestion and reducing gastrointestinal incidents and slightly less on reducing body fat. For the reduction of body circumference and appetite, the results were intermediate - "it is difficult to say whether there was a noticeable change". For the presented categories, all variables correlated with each other, giving the average correlation index at the level of r = 0.79. Tab 4.

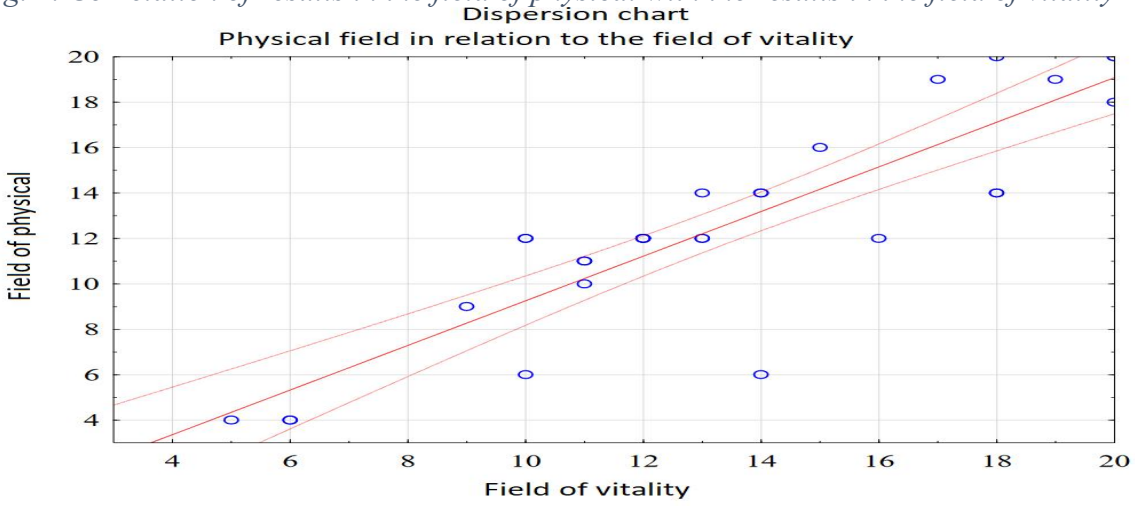
Tab. 4. The results of the answers for the components of the field of physical and the total result

Variable	Rating					
	Definitely not - 1	Probably not - 2	It's hard to say - 3	Rather yes - 4	Definitely yes - 5	M
Fat reduction	3 (10%)	6 (20%)	9 (30%)	7 (23,3%)	5 (16,7%)	3,2
Reduction of body circumference	4 (13,3%)	6 (20%)	11 (36,7%)	4 (13,3%)	5 (16,7%)	3
Improving digestion, reducing gastrointestinal incidents	5 (16,7%)	2 (6,7%)	8 (26,7%)	6 (20%)	9 (30%)	3,4
Regulation of appetite	4 (13,3%)	7 (23,3%)	10 (33,3%)	5 (16,7%)	4 (13,3%)	2,9
Total score	mean + SD = 12,50±4,67 median (Q1-Q3) = 13 (11-14)					

Note: Data are presented as number of patients or mean and standard deviation

Both variables, the field of vitality and the field of physical, correlate with each other, giving the index r = 0.87. Thus, in people who felt better, had fewer gastrointestinal problems or accelerated metabolism, they also reduced body weight and improved digestion.

Fig. 1. Correlation of results in the field of physical with the results in the field of vitality



There were significant differences in the results between men and women for the field of physical. Women had a significantly higher result, which means that they were more susceptible to the effects of supplements. Individuals who achieved a weight loss score significantly higher for the field of physical.

It also turned out that although weight loss (60% of respondents) and the absence of gastrointestinal problems (73.3% of respondents) during supplementation were observed in both groups, they occurred in a greater amount in women than in men, and the differences these were statistically significant. Higher effectiveness among women may be the result of differences in the functioning of the endocrine system, although it is certainly worth taking a closer look at this issue. 40% of respondents did not notice any weight loss while taking supplementation (Tab. 6).

Tab. 6. Comparison of the results for the field of physical by gender, number of meals during the day, weight reduction, gastrointestinal problems

Group		M	SD	Me	P
Sex	Women (n=20)	13,90	4,49	13	0,028
	Men (n=10)	9,70	3,83	11	
Number of meals during the day	Four or more meals (n=22)	12,18	5,21	12	0,775
	Up to three meals (n=8)	13,38	2,83	12	
Weight reduction after testing the supplement	Yes (n=18)	14,67	4,03	14	0,002
	No (n=12)	9,25	3,65	12	
Gastrointestinal problems	Lack (n=22)	13,41	4,66	12	0,060
	Present (n=8)	10,00	3,96	11	

Note: Data are presented as mean, standard deviation and median; Test Manna-Whitney`a

Discussion

The use of dietary supplements to accelerate metabolism and reduce body weight is becoming more and more common, although the goals of its users are different. A study conducted on 813 women showed that every third woman used supplementation to reduce body weight at least once in a lifetime. The most frequently indicated reasons for supplementation were: the desire to achieve a dream figure, care for the appearance and acceleration of the weight loss process. It turned out that most of the women included in the study made at least one attempt to reduce body weight, of which nearly 40% used a dietary supplement for this purpose. The decision about supplementation was most often made by women on their own, and only a few of them used the help of a specialist or scientific literature [19]. Another study involving 150 students (125 women, 24 ± 2 years and 25 men, 23 ± 2 years) was divided into two groups: A - people using dietary supplements to influence metabolism; B - people not using supplements. It turned out that the reasons for using supplements are mainly aesthetic (63.8% of people), low self-esteem (48.3% of people) and fashion for a slim figure (29.3% of people) [20]. Suppression of appetite, regulation of lipid metabolism and increased energy expenditure are the main mechanisms acting against obesity, that's why plant-based supplements seem to be helpful. Plants are the best-studied natural

source of bioactive anti-obesity agents. Camellia sinensis (Chinese tea) is the most representative species with a number of anti-obesity effects.

One of the ingredients of the supplement that was used by the group of subjects in this study was the artichoke. Cynarin, considered to be the most important active ingredient of artichoke, is distinguished primarily by its hepatoprotective effect. It counteracts fatty liver and also has a strong antioxidant effect. It also has a strong choleretic effect: it stimulates the secretion of bile and the production of bile acids, which reduces the cholesterol pool in the liver [21]. Lowering cholesterol is also due to the interaction of its luteolin with HMG-CoA reductase. One meta-analysis involving 9 studies and 702 people showed a significant reduction in concentration: TC (-17.6 mg / dl; $p < 0.001$), LDL-C (-14.9 mg / dl; $p = 0.011$) and TG (- 9.2 mg / dl; $p = 0.011$), with no significant effect on HDL-C concentration (+1.0 mg / dl; $p = 0.333$) [22].

Another ingredient contained in the tested supplement is nettle extract. The results of the research indicate that it is mainly forskolin contained in the raw material that is responsible for the pharmacological activity of herbal raw materials obtained from this plant and their products. The mechanism of action of forskolin is based on the activation of the enzyme adenylate cyclase, which causes the synthesis of cyclic AMP (cAMP) from adenosine-5'-triphosphate (ATP). Thus, by stimulating cAMP, Forskolin increases the level of intracellular cAMP, which regulates and influences the activity of many enzymes in the cell [23, 24]. It is especially beneficial in many diseases such as asthma, cardiovascular disorders, hypertension, obesity, psoriasis. These diseases show a decrease in the level of intracellular cAMP [25].

According to various studies, among natural compounds, celery (Apium graveolens) is one of the most important sources of phytochemicals such as phenolic acids, flavones, flavonols and antioxidants such as vitamin C, beta-carotene (provitamin A) and manganese. These antioxidants play a role in reducing oxidative damage. The phytochemicals in celery reduce the activity of pro-inflammatory cytokines and prevent inflammation. In addition, the flavonoids in celery inhibit inflammation in the circulatory system. Oxidative stress and inflammation in the bloodstream are the main risk factors for the worsening of cardiovascular diseases, especially atherosclerosis. Celery phthalides lead to the expansion of smooth muscles in the blood vessels and a reduction in blood pressure. As a result, the most active components of celery (A. graveolens) show hypolipidemic, antidiabetic and hypotensive properties [26]. Due to the rich and varied content of phenolic compounds, minerals and vitamins, celery has antioxidant and antibacterial properties, as well as a number of other pro-health activities [27].

The extracted aurapten is a bioactive monoterpene coumarin ether which has been found in celery to have strong antioxidant and liver protective properties [28]. Moreover, the results of studies conducted on elderly people with pre-diabetes indicate that celery may lower blood glucose levels before meals, and may also lower blood glucose levels after meals (decrease by 19.5%) [29, 30, 31]. The use of tamarind in the studied supplement is justified due to the support of weight reduction. The raw material used in traditional medicine and in the food industry is the yellowish fruit of Garcinia cambogia. It is used as a spice in Thai and Indian cuisines. The main active ingredient of the raw material is hydroxycitric acid (HCA). Analyzing the publications on Garcinia cambogia, data was found in favor of its beneficial use in the prevention of obesity. Administration of 2.4 g of tamarind tree seed extract standardized to hydroxycitric acid for 3 months resulted in a slight but statistically significant decrease of 1.3 kg of body weight [32, 33]. Vasques et al. assessed the influence of G. cambogia on anthropometric, metabolic and lipid parameters in obese, healthy women (BMI> 25 kg / m2; age 25-60 years). The women were divided into a group receiving 800 mg of Garcinia cambogia extract (50% HCA) ($n = 30$) and control ($n = 13$) placebo 3 times a day 30

minutes before meals. The studies were carried out for 60 days with simultaneous dietary control. Before starting the study, participants were instructed to reduce their caloric intake (an average of 500 kcal / day). The mean changes in BMI were 0.17 ± 0.56 kg / m2 in the group consuming the extract and 0.24 ± 0.87 kg / m2 in the placebo group. The mean changes in fat mass were 0.12% ± 5.4% in the group consuming the extract and 0.21% ± 4.15% in the placebo group. Apart from that, no statistically significant differences were found in the other parameters, except for the triglyceride level. In the group consuming the extract, the mean reduction in triglyceride levels was 132.35 ± 41.61 mg / dl before treatment and 109.52 ± 38.7 mg / dl after treatment (p = 0.0002) [34]. Nevertheless, there are also results suggesting the lack of influence of G. cambogia on weight loss [35]. In addition, there are reports of hepatotoxicity caused by hydroxycitric acid. On this basis, it is proposed to limit or even withdraw from the use of Garcinia cambogia extracts [36].

It should be remembered that Supplements are not drugs, although they are perceived by many. The apparent resemblance only ends in the external appearance (packaging) and (sometimes) the appearance, characters. Unlike supplements, drugs are products that are subject to continuous, strict control at every stage of production and distribution, in order to meet the highest safety and quality standards [37]. A dietary supplement may contain substances that are also found in medicinal products (e.g. some vitamins and minerals), but they should be present in a much lower concentration, not producing a therapeutic effect. It should be emphasized that no product can be both a dietary supplement and a drug [38]. Adulterated products are most often produced outside the EU (United States, China), and the largest number of them is available in non-pharmacy trade, mainly on the Internet. Taking such products is associated with enormous risks and can cause permanent damage to your health. Contaminated, inhomogeneous products, containing doses of substances inconsistent with the declared doses or unreliably labeled, are also a threat to consumers [39, 40, 41] The effectiveness of natural preparations in reducing body weight is not yet fully confirmed. Natural preparations differ in their chemical structure, which means that they have different mechanisms of action, which is a large area for research into their use in the treatment of obesity [42].

Conclusions:

Plant-based supplements reduce body weight and metabolism, and may also alleviate gastrointestinal discomfort. In addition, they improve digestion in general, increase vitality and, to a small extent, may contribute to the improvement of the immune system. They do not significantly improve appetite. Dietary supplements based on plant extracts have a greater effect on women than on men. Side effects have not been reported in either male or female groups.

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