

***Cyperus esculentus* L. as a biotechnological raw material and substitute for peanuts in the production of confectionery products**

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Abstract. A comparative chemical composition of peanuts and *Cyperus esculentus* – a raw material that does not contain gluten, rich in fat, vitamins and minerals, is given. The possibility of replacing crushed peanuts with alternative raw materials – *Cyperus esculentus*. nodules is considered. Appropriate preparation of raw materials is offered. Sprinkling shortcake dough with crushed *Cyperus esculentus* . nodules, pre-soaked for 12 hours in water, fried and crushed will increase the nutritional value of the product.

1 Introduction

Since time immemorial, biotechnology has been used mainly in the food and textile industry, namely, in winemaking, baking, fermentation of dairy products, processing of flax, leather, etc., i.e. in processes based on the use of microorganisms. In recent decades, the possibilities of biotechnology have expanded enormously. Today, the objects of biotechnology are viruses, bacteria, protista, yeast, as well as plants, animals, or isolated cells and subcellular structures (organelles) [1].

The modern food industry, as a branch of biotechnology, is engaged in the study and development of the theory and practice of creating food products for general, therapeutic and preventive purposes and special orientation. This is the industry of food ingredients – auxiliary technological additives introduced into food products during their manufacture to increase their useful properties [2].

A huge number of food ingredients are currently imported, and therefore, the organization of their production in Russia is an urgent, socially demanded task. One of these natural food ingredients of functional significance is the *Cyperus esculentus*, – a representative of the Cyperaceae Juss.

The genus *Cyperus* L. in the world flora is represented by 300 species distributed in tropical, subtropical and less often – temperate regions of the planet. There are only 14

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species in Russia, and 5 species grow in the Far East: *Cyperus glomeratus* L., *C. difformis* L., *C. fuscus* L., *C. orthostachyus* Franch.et Savat., *C. Amuricus* Maxim. [3]

Cyperus esculentus does not grow in the Far East, it is typical for regions of the Northern hemisphere with a climate from moderate to subtropical. It is considered to be native to the Mediterranean and North Africa.

The crop is not widespread, although it has a high nutritional value and a pleasant taste. In Russia, *Cyperus esculentus* has been known since the end of the XVIII century under the names “zimovnik” and “syt”, currently it is more often called “chufa”, ground almonds or tiger nuts.

Cyperus esculentus - is a perennial herb, representative of the Cyperaceae Juss, cultivated as a food plant because of the edible nodules on the roots [4] (fig. 1).



Fig. 1. Morphology of *Cyperus esculentus* L.

Cyperus esculentus – is one of the first plants cultivated by man: vessels with nodules were discovered by archaeologists in the tombs of Egyptian pharaohs. Tiger nuts were used by the ancient Egyptians for medical purposes: cleaning the mouth, enema, ophthalmology, ointment for dressing wounds, as well as incense for fumigating homes and clothing along with myrrh incense [5-6].

From Egypt, Arab merchants spread the tiger nut to the North and West of Africa, Sicily, and Spain. Tiger nuts are known in other parts of the world, especially in the region of Valencia (Spain) [7-8].

In recent years, innovative enterprises that are engaged in both growing and processing exclusive plants to produce biologically valuable products, in particular, LLC “Russian Oliva” (Voronezh), have shown an active practical interest in ground almonds in Russia [9].

Cyperus esculentus nodules contain up to 28% of fatty oil, 15-20% of sugars, 20-25% of starchy substances, about 2% of crude protein, and other substances [10].

Doctors recommend using *Cyperus esculentus* nodules for people with diabetes. Milk from ground *Cyperus esculentus* contributes to the treatment of gastrointestinal diseases.

Cyperus esculentus helps to purify the body and removes radionuclides from it. The taste and smell of the nodules of this plant resemble almonds. Flour from Cyperus esculentus nodules is added to the dough when baking cupcakes, cookies, bread and marzipan products. To make gluten-free bread, it is possible to combine chickpea, amaranth flour and flour from Cyperus esculentus nodules [11-14]. Good indicators were obtained when adding the product of processing Cyperus esculentus to bakery products in the amount of 3, 4 and 5% of the amount of wheat flour of the highest grade in the recipe [15]. Research conducted at the Moscow State University of Food Production has proved that adding 5% of tiger nuts instead of raw meat is effective [16]. A draft of technical specifications for “Aromatniy” pate and semi-finished products stuffed and chilled from poultry meat with the introduction of processed Cyperus esculentus products has been developed [17].

The purpose of the research - is to evaluate the possibility and method of using nodules of Cyperus esculentus grown in the agro-ecological conditions of the Primorsky Krai as a substitute for peanuts in the production of confectionery products (sprinkling cakes made from shortbread dough).

2 Materials and methods

The research was conducted in the bakery department of the student nutrition combine of the Federal State Budgetary Educational Institution of Higher Education “Primorskaya State Agricultural Academy” (hereinafter referred to as the – FSBEI HE Primorskaya SAA).

To conduct a comparative analysis of the quality and nutritional value of Cyperus esculentus and peanuts, we baked rings-shortbread cakes according to a standard recipe. The recipe includes flour of the highest grade, margarine, eggs, sugar, peanuts. All raw materials meet the requirements of standards and specifications.

The order of research included the following stages: 1) development of an optimal method for preparing raw material, 2) establishment of raw material quality indicators, 3) baking cakes, and their organoleptic assessment, 4) calculation of energy value, fat content, protein and carbohydrates of finished products.

To conduct research, we took Cyperus esculentus nodules obtained as a result of cultivation on the collection site of the Academy within the framework of the final qualifying work.

Cyperus esculentus was sorted, cleaned of impurities, unnecessary nodules and earth, and then washed. Cyperus esculentus nodules had a pleasant taste and smell, characteristic of this species, without extraneous smell and/or bitter taste, without mustiness and rancidity. Nodules were crushed and ground in a laboratory mill.

To study Cyperus esculentus as a nut substitute, the following processing options were investigated:

1. Nut of peanut crushed, peeled, fried – control.
2. Cyperus esculentus nodules are not fried, ground into a powder.
3. Cyperus esculentus nodules are fried, soaked for 4 hours, ground into a powder.
4. Cyperus esculentus nodules are fried, soaked for 4 hours, crushed.
5. Cyperus esculentus nodules are fried, soaked for 8 hours, ground into a powder.
6. Cyperus esculentus nodules are fried, soaked for 8 hours, crushed.
7. Cyperus esculentus nodules are fried, soaked for 12 hours, ground into a powder.
8. Cyperus esculentus nodules are fried, soaked for 12 hours, crushed.

Based on the results of the organoleptic evaluation of the experimental samples, the optimal method of using Cyperus esculentus as a sprinkling shortbread cakes was determined.

3 Results and discussion

As a result of research, it was found that peanuts have a yellow color with brownish inclusions after frying, the taste of peanuts is sweet, nutty, characteristic of peanuts.

Fresh *Cyperus esculentus* nodules have a very firm consistency, so they need to be soaked for a softer consistency. The taste of the nodules of fresh *Cyperus esculentus* is sweet, resemble almonds. After 4, 8 and 12 hours of soaking and frying the nodules, the taste changes and resembles coffee, the color is different – from brown, with inclusions of white pulp to dark brown, with inclusions of brownish pulp (table 1).

Table 1. Organoleptic evaluation of peanuts and *Cyperus esculentus* after processing.

Variant	Color	Smell	Taste
Nut of peanut crushed, peeled, fried	brown	specific, characteristic of peanuts	sweet, characteristic of peanuts
<i>Cyperus esculentus</i> nodules are not fried, ground into a powder.	brown	walnut	sweetish
<i>Cyperus esculentus</i> nodules are fried, soaked for 4 hours, ground into a powder.	brown with inclusions of white pulp	with a hint of coffee, pronounced strongly	sweet, with a hint of coffee
<i>Cyperus esculentus</i> nodules are fried, soaked for 4 hours, crushed.	brown, uneven	with a hint of coffee, pronounced strongly	sweet, with a hint of coffee
<i>Cyperus esculentus</i> nodules are fried, soaked for 8 hours, ground into a powder.	Smooth brown	the smell of coffee is strongly pronounced	bitter, slightly sweet, coffee flavor
<i>Cyperus esculentus</i> nodules are fried, soaked for 8 hours, crushed.	brown, with inclusions of brownish pulp	the smell of coffee is strongly pronounced	bitter, coffee flavor
<i>Cyperus esculentus</i> nodules are fried, soaked for 12 hours, ground into a powder.	dark brown	with a hint of coffee, pronounced strongly	very bitter, coffee flavor
<i>Cyperus esculentus</i> nodules are fried, soaked for 12 hours, crushed.	dark brown, with inclusions of brownish pulp	with a hint of coffee, pronounced strongly	sweet, coffee flavor

Peanuts, because of high fat content, are not crushed into powder, it can only be split into pieces. *Cyperus esculentus* L., due to its lower fat content, crumbles well into powder and can be added to flour, you can sprinkle it on top of confectionery, and unlike peanuts, it does not cause allergies.

Cyperus esculentus nodules contain almost 2 times more nitrogen-free extractives than peanuts. The nodules contain - fiber, a lot of vitamins and amino acids. A comparative analysis of raw material is presented in table 2.

Table 2. Chemical composition of peanuts and *Cyperus esculentus* L.

chemical composition	Peanuts	<i>Cyperus esculentus</i> L
Fats, %	42.0	21.8
Protein, %	26.6	7.1
Water, %	7.9	9.5
Nitrogen-free extractives, %	17.7	49.9
Fiber, %	8.1	17.0

From all the proposed variants of the experiment, it was found that *Cyperus esculentus* nodules soaked for 8 hours, fried, ground into powder and *Cyperus esculentus* nodules soaked for 12 hours, fried and crushed into pieces have the best organoleptic characteristics. These options were used for sprinkling cakes.

As a result, it was determined that the appearance of the cakes, when sprinkled with crushed *Cyperus esculentus* nodules, is better than ground, and the loss of sprinkling is less (figure 2). It is better to add ground *Cyperus esculentus* nodules to the dough, and use crushed *Cyperus esculentus* as a sprinkle.



Fig. 2. The appearance of the cakes of dough: 1) cakes sprinkled with peanuts; 2) cakes sprinkled with fried and crushed *Cyperus esculentus* nodules; 3) cakes, sprinkled with fried and ground *Cyperus esculentus* nodules.

Calculation of the energy value of a sprinkle of peanuts and *Cyperus esculentus* showed that the caloric content of *Cyperus esculentus* nodules is 1.8 times lower than the caloric content of peanuts and amounts to 293 kcal or 1223 kJ (table 3).

Table 3. Calculation of the energy value of peanuts and *Cyperus esculentus* L.

Name of product	Content, g			Energy value, kcal/kJ
	protein	fats	carbohydrates	
Peanuts	26.6	42.0	8.1	517/2160
<i>Cyperus esculentus</i> L.	7.1	21.8	17.0	293/1223

The reduction in caloric content is mainly due to the lower fat content in *Cyperus esculentus* nodules – 21.8 g/100g of the product, while its content in peanuts is 42.0 g/100g of the product.

4 Conclusion

This paper presents a scientific and theoretical justification for the prospects of using *Cyperus esculentus* as a biotechnological raw material and nut substitute in the food and confectionery industry and the introduction and cultivation of *Cyperus esculentus* in the Far East, including the Primorsky Krai.

The features of geographical location of the Primorsky Krai and its agro-climatic resources make it possible to grow *Cyperus esculentus* on a production scale, since in the wild flora representatives of this genus favorably tolerate the specific monsoon climate of the region under study.

In comparison with peanuts, *Cyperus esculentus* nodules contain less fat – 21.8 g/100, protein – 7.1 g/100 and more nitrogen – free extractives - 49.9%. Unlike peanuts, *Cyperus esculentus* protein does not cause allergies. To sprinkle products made from shortbread dough, it is recommended to soak the *Cyperus esculentus* nodules for 8 or 12 hours, fry and crush.

Also, the introduction of *Cyperus esculentus* is a biotechnological raw material in the food industry.

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