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DEVELOPMENT OF RECIPES OF PLANT-BASED BEVERAGES BASED ON SUNFLOWER PROTEIN CONCENTRATE

Annotation

The research indicates the factors that contribute to the development of the plant-based milk industry in Ukraine, provides an analysis of the plant-based milk market in Ukraine and the world, shows the prospects for the development of this segment over the next decade in the country, outlines the segment of Ukrainians who are potential consumers of the target product – plant-based milk. Based on the analysis of literary data, the relevance and expediency of processing sunflower protein concentrates, which are currently produced in Ukraine by enterprises of the oil and fat industry, into plant-based beverages is substantiated. The perspective and expediency of using fillers - cocoa powder, sugar, natural flavorings and dyes, amylolytic enzymes, thickeners, spices (turmeric, curry, cocoa powder), acidity regulators - in recipes of plant-based drinks based on dry defatted sunflower protein concentrate is shown. The basic recipes of plant-based drinks were compiled on the basis of the analysis of literature data on the chemical composition of drinking cow's milk and various types of "plant-based milk" existing in Ukraine, using gray sunflower protein concentrate as the main raw material, which is produced on an industrial scale by the Ukrainian oil-extraction plant Plant №1 "Potoky" LLC, Dnipro. Based on the analysis of the organoleptic indicators of herbal drinks produced according to the basic recipes, the feasibility of producing another type of basic raw material - dry defatted sunflower protein concentrate - with improved organoleptic indicators, in particular, with white color, was substantiated. The basic enterprise improved the production technology of sunflower protein concentrate and a line of plant-based drinks was developed on the basis of dry, defatted sunflower white protein concentrate. The result of the work was three recipes of herbal drinks: a drink with a "Sweet Cream" flavor, a drink with a "Melon" flavor, and a "Chocolate" drink. The organoleptic evaluation of herbal drinks produced according to the developed recipes confirmed their high sensory characteristics.

Key words: plant-based drink, sunflower protein concentrate, filler, flavoring, organoleptic evaluation, formulation.

Introduction

Experts note that Ukraine has great potential as well as a favorable geographical location, certain climate conditions and natural resources that contribute to the development of the livestock industry and dairy industries. A serious challenge the dairy industry's producers is the spread of healthy eating trends in society, within which the consumption of "vegetable milk" as an alternative to animal milk is increasing, in Ukraine the market of "vegetable milk" exists and is developing on the wave of the spread of healthy nutriotion trends and the spread of information about the detriments of cow's milk consumption. Despite the unconfirmed nature of such data, they affect a fairly significant part of the population [1].

Consumers of "vegetable milk" include people who want to diversify their diet. Some people simply cannot consume traditional milk due to lactose allergy, which leads to many consumers adopting ideas of vegetarianism or other kinds of health-minded dietary choices. For these people, "vegetable milk" can become a complete substitute for cow's milk. All this pushes the demand for almond, coconut, hemp, rice and other types of "vegetable milk" [1–4].

The advantage of producing "vegetable milk" is that it does not require the upkeep of livestock, as it is completely replaced by a complex of equipment for loading raw materials and obtaining an output of healthy drinks, similar in appearance and composition to milk.

At the same time, the disadvantages of "plant milk" include the fact that it contains gluten and is not suitable for people prone to common allergies, such as nut allergies. Therefore, the most common products on the "vegetable milk" market in Ukraine are soy and oat products, which contain the fewest allergens [1–2].

Plant milk is gaining more and more popularity in the world as a substitute for traditional dairy milk. Realizing the potential of the "vegetable milk" market in the USA, Canada, and Europe, even enterprises that used to produce traditional milk are switching to its production, and some livestock farms are turning into almond groves (Fig. 1) [2].

In the period from 2012 to 2017, the volume of sales of "plant milk" in the world increased by 61%, while the revenue from the sale of cow's milk decreased by 15% [5, 6].

The "vegetable milk" market developed in Ukraine recently, after the arrival of the corresponding consumption trends from the USA and the UK. The growth in demand for "plant milk" in our country was clearly felt circa 2017, and in 2018, the first domestic producer of this type of product began operating in the Vinnytsia region. - "Lustdorf" LLC, which launched the

production of the first two products – oat and buckwheat "not milk" IDEAL [4, 7–8].

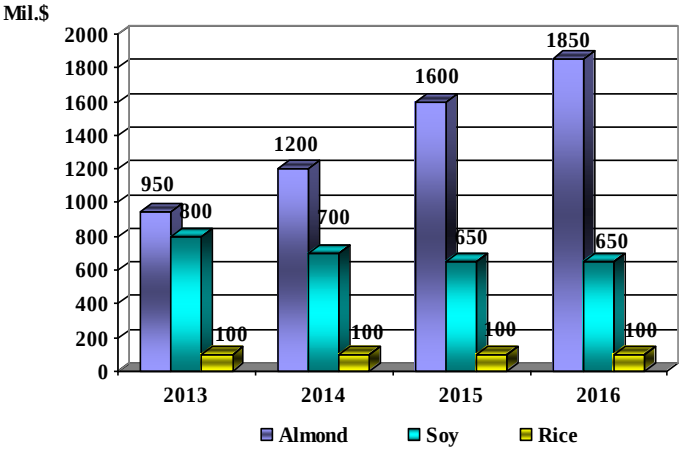

Fig. 1 – Net worth of plant-based milk substitute products produced worldwide

Monitoring of the vegetable milk market in Ukraine shows that a sharp increase in its production took place in 2020, after the development of this production line by JV "Vitmark Ukraina" LLC (Fig. 2) [1].

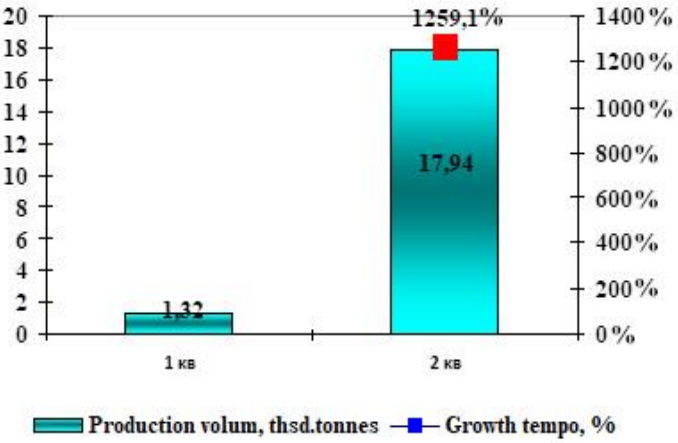

Fig. 2 – Plant-based milk producation dyamics (2019-2020) in Ukraine, in natural terms

The analysis of the "plant milk" market in Ukraine made it possible to identify the following factors affecting it as most significant [1]:

– the demographic indicators of our country;

– the number of consumers who do not consume animal products and are lactose intolerant;

– the yield of raw agricultural crops and their price.

The development of the "vegetable milk" market in Ukraine is restrained by its higher price compared to traditional cow's milk.

Supermarkets and online stores are the most capacious sales channels for the"vegetable milk" market's produce in Ukraine. Implementation through restaurants and cafes is dynamically developing, which is connected with the growing demand (Fig. 3) [1].

The assortment of "vegetable milk" on the ukrainian market is constantly increasing. Today, the consumer is morally ready to buy new types of "plant milk", so the issue of finding new types of raw materials for its production is urgent [6].

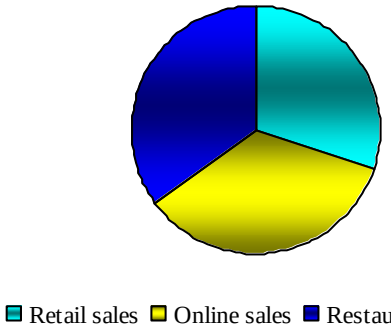

Fig. 3 – Estimation of the market share by «vegetable milk» sales channels

Therefore, the goal of this research effort was the development and implementation of recipes and technology of plant-based drink production based on dry defatted sunflower protein concentrate (DDSPC) at JV "Vitmark Ukraina" LLC.

Research tasks:

– justify the choice of the main and auxiliary raw materials for the production of an assortment of "Sonyashnikovy" vegetable drinks based on sunflower protein concentrate;

– to determine the rational mass fractions of the main and auxiliary raw materials for the production of "Sonyashnikovy" vegetable drinks with fillers, which ensure the production of target products with high organoleptic characteristics and standardized physico-chemical and microbiological indicators;

- develop recipes for plant-based drinks based on dry defatted sunflower protein concentrate.

Materials and methods

The main raw material for the production of plant-based drinks was selected dry defatted sunflower concentrate (DDSC), which is produced by the Ukrainian oil extraction plant No. 1 of Potoky LLC (Dnipro) according to TU U10.9-40832205-001:2019 (concentrate quality indicators are given in Table 1).

Additional raw materials used for research:

- Spices – curry and turmeric marked «Eco», produced by PAT «Ecotechnika» (Kagarlyk, Ukraine);
- Granulated sugar (DSTU 4623:2006);
- Cocoa-powder (DSTU 4391:2017);
- Natural food flavoring "Sweet Cream" JE-02-06-135, "Melon" JE-02-06-139, "Chocolate" JE-02-06-140;
- "Chocolate" food coloring produced by Hr. Hansen (Denmark);
- Hamulsion thickener (CNM JE-02-06-172);
- Amylolytic enzymes alpha-amylase JE-02-06-175 and glucoamylase JE-02-06-176;
- Acidity regulator JE-02-06-168;
- Sensory methods of analysis were used to determine the organoleptic parameters of vegetable drinks based on sunflower protein concentrates.

Results of the study and their discussion

Sample 1 of DDSC has a grayish-greenish color, a homogeneous finely dispersed consistency and a light aroma of sunflower (Table 1, Fig. 4). At the time of the

Table 1 – Quality indicators of dry defatted sunflower concentrate (DDSC)

Indicator name	Characteristics and value of the indicator for sample 1 DDSC
Product description	Homogeneous fine disdeprsity mass of various shades of gray, the taste and smell are specific, inherent in the sunflower kernel product
Calorie content, kJ	1509,0
Energy value, kkal	355,0
Proteins, g	53,0
Fats, g	1,5
Carbohydrates, g	41,5
Total sugar content, g	9,5
Food fibers, g	7,0
Ash content, g	0,1
Salt (in terms of sodium), g	0,01
Cobalt, mg/kg	1,45
Manganese, g/kg	34,90
Vitamin A, g/kg	2,44
Vitamin E, mg/kg	68,00
Cholesterol	–

research, the manufacturing enterprise was already selling this concentrate to meat processing enterprises.

To "mask" the color in plant-based drinks based on DDSC, it was decided to use cocoa powder and the "Chocolate" filler (for the "Chocolate" drink), as well as spices - turmeric and curry. The production of a classic plant-based beverage on the basis of the DDSC sample presented for research is impossible, taking into account its color.

Fig. 4 – Appearance of Sample 1 of DDSC

Fig. 5 – Plant-based beverage based on DDSC (no added fillers) according to TU U 10.9-40832205-001:2019

Table 2 – Basic recipes of plant-based drinks based on the DDSC sample (Sample 1) – taken in kg per 100 kg of product without taking into account losses

Raw material name	Raw material mass, kg, for plant-based drink				
	«Chocolate» in accordance to the recipe		containing turmeric in accordance to the recipe		containing curry in accordance to the recipe 3-1
	1-1	1-2	2-1	2-2	
Dry defatted sunflower concentrate (DDSC)	5,5	5,5	7,5	7,5	7,5
Sugar	3,0	3,0	1,0	1,0	1,0
Salt	0,1	0,1	0,1	0,1	0,1
Cocoa-powder	2,0	–	–	–	–
Natural food flavoring "Chocolate"	0,05	0,05	–	–	–
"Chocolate" food coloring	–	0,7	–	–	–
Turmeric	–	–	0,3	0,5	–
Curry	–	–	–	–	0,5
Water prepared by reverse osmosis	89,35	90,65	90,7	90,5	90,9
Total:	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**

The basic recipes of plant-based drinks (Table 2) were compiled based on the analysis of literature data on the chemical composition of traditional cow's milk and various types of existing "plant-based milk".

The organoleptic indicators of herbal drinks "Chocolate" are shown in fig. 6, 7 and in table. 3, drinks containing turmeric - in fig. 8, 9 and in table. 4, drinks containing curry - in fig. 10, 11 and in table. 5.

Fig. 6 – Plant-based drink "Chocolate" according to recipe 1-2 compared to the control sample

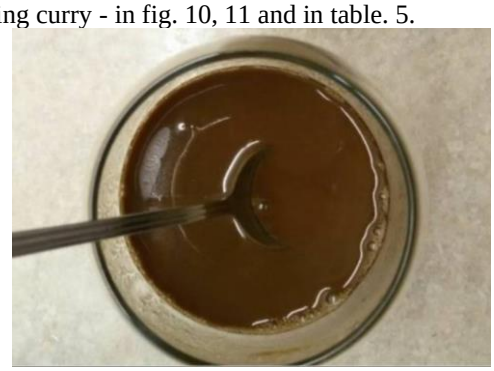

Fig. 7 – Plant-based drink "Chocolate" according to recipe 1-1

Table 3 – Organoleptic indicators of herbal drinks "Chocolate" basde on the sample of DDSC (Sample 1)

Indicator name	Characteristics of the indicator
Plant-based drink "Chocolate" according to recipe 1-1	
Flavor and aroma	Sweet, with the taste of cocoa powder, with the aroma of chocolate and a light aftertaste of sunflower seeds
Consistence	Liquid, with a slight sediment at the bottom of the glass
Color	Dark brown, characteristic of chocolate drinks, uniform over the entire mass of the drink
Plant-based drink "Chocolate" according to recipe 1-2	
Flavor and aroma	Sweet, with a muted chocolate taste, with the aroma of chocolate and a light aftertaste of sunflower seeds
Consistence	Liquid, with a slight sediment at the bottom of the glass
Color	Brown, characteristic of coffee drinks, uniform over the entire mass of the drink

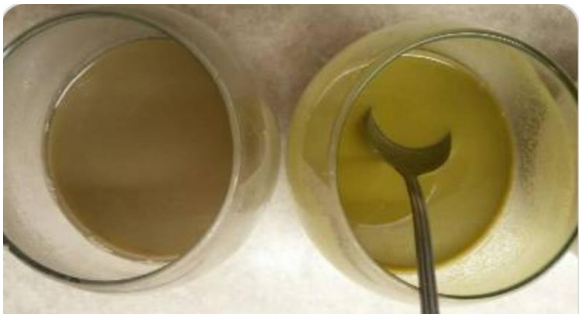

Fig. 8 – Plant-based drink containing turmeric according to recipe 2-2 compared to the control sample

Fig. 9 – Plant-based drink containing turmeric according to recipes 2-1 and 2-2

Table 4 – Organoleptic indicators of herbal drinks containing turmeric based on the sample of DDSC (Sample 1)

Indicator name	Characteristics of the indicator
Plant-based drink containing turmeric according to recipe 2-1	
Flavor and aroma	Characteristic of a sunflower drink, slightly sweet, with a slight sharpness, with the aroma and light aftertaste of sunflower seeds
Consistence	Liquid, with a slight sediment at the bottom of the glass
Color	Gray-olive, uniform over the entire mass of the drink
Plant-based drink containing turmeric according to recipe 2-2	
Flavor and aroma	Characteristic of a sunflower drink, slightly sweet, with a pronounced sharpness, with the aroma and light aftertaste of sunflower seeds
Consistence	Liquid, with a slight sediment at the bottom of the glass
Color	Olive-yellow, uniform over the entire mass of the drink

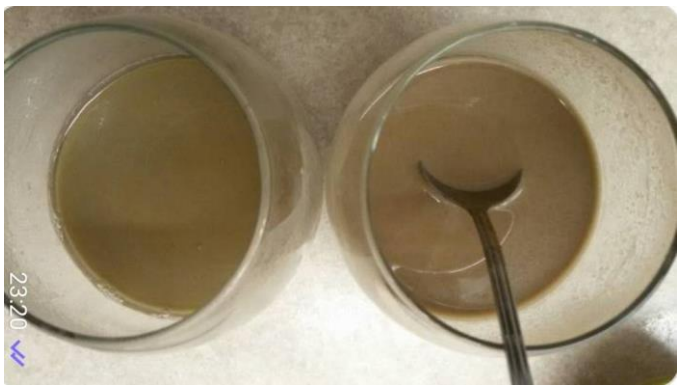

Fig. 10 – Plant-based drink containing curry according to recipe 3-1 compared to the control sample

Fig. 11 – Plant-based drink containing curry according to recipe 3-1

Table 5 – Organoleptic indicators of herbal drinks containing curry based on the sample of DDSC (Sample 1)

Indicator name	Characteristics of the indicator
Plant-based drink containing curry according to recipe 3-1	
Flavor and aroma	Characteristic of a sunflower drink, slightly sweet, with a slight sharpness, with the aroma and light aftertaste of curry and sunflower seeds
Consistence	Liquid, with a slight sediment at the bottom of the glass
Color	Grayish coffee-brown with red spots of curry, not uniform over the entire mass of the drink

a) b)

Fig. 12 – Appearance of sample 1 (a) and sample 2 (b) of dry defatted sunflower protein concentrate

The conducted research shows that only the herbal drink "Chocolate" with the addition of cocoa powder can be produced on the basis of gray DDSC, which has been produced on an industrial scale by the Ukrainian oil extraction plant No. 1 "Potoky" LLC, Dnipro since 2019. However, it is desirable to bring to the market a line of drinks, and not a single product, therefore the manufacturing company improved the technology of the concentrate production in order to improve the organoleptic indicators, namely, to obtain a white or cream color.

The characteristic grayish color of sample 1 of the concentrate is due to the formation of polyphenols in the process of oil extraction with hexane after pressing, therefore the extraction process was removed from the technology. Sample 2 of the concentrate contains 9% more proteins than sample 1 and has a pleasant white color (Fig. 12).

Further studies were carried out with sample 2 of dry defatted sunflower protein concentrate (DDSC).

The basic recipes of plant-based drinks based on sample 2 are given in table 6.

Table 6 – Basic recipes of plant-based drinks based on the DDSC sample (Sample 2) – taken in kg per 100 kg of product without taking into account losses

Raw material name	Raw material mass, kg, for plant-based drink		
	«Sweet Cream» flavored	«Melon» flavored	«Chocolate»
Dry defatted sunflower concentrate (DDSC)	6,5	6,5	5,5
Sugar	1,0	1,0	3,0
Salt	0,1	0,1	0,1
Cocoa-powder	–	–	2,0
Natural food flavoring "Chocolate"	–	–	0,05
Natural food flavoring "Sweet Cream"	0,05	0,05	–
Natural food flavoring "Melon"	–	–	–
Water prepared by reverse osmosis	92,35	92,35	89,35
Total:	**100,0**	**100,0**	**100,0**

Fig. 13 – Plant-based drink with «Sweet Cream» flavoring

Fig. 14 – Plant-based drink with «Melon» flavoring

Fig. 15 – Plant-based drink «Chocolate»

Table 7 – Organoleptic indicators of plant-based drinks produced based on DDSC (Sample 2)

Indicator name	Characteristics of the indicator
Plant-based drink «Chocolate»	
Flavor and aroma	Sweet, characteristic of chocolate drinks, with the taste of cocoa powder, with the aroma of chocolate and a light aftertaste of sunflower seeds
Consistence	Liquid, with a slight sediment at the bottom of the glass
Color	Dark brown, characteristic of chocolate drinks, uniform over the entire mass of the drink
Plant-based drink with «Sweet Cream» flavoring	
Flavor and aroma	Slightly sweet, characteristic of a sunflower drink, with a creamy aroma and a light aftertaste of sunflower seeds
Consistence	Liquid, with a slight sediment at the bottom of the glass
Color	Light-cream, uniform over the entire mass of the drink
Plant-based drink with «Melon» flavoring	
Flavor and aroma	Sweet, characteristic of a sunflower drink, with the aroma of melon and a light aftertaste of sunflower seeds
Consistence	Liquid, with a slight sediment at the bottom of the glass
Color	Light-cream, uniform over the entire mass of the drink

The organoleptic quality indicators of the produced three samples of herbal drinks - "Chocolate", "Sweet Cream" flavoring and "Melon" flavoring - are shown in fig. 13-15 and in table 7).

The conducted research made it possible to recommend all three developed recipes of plant-based drinks for development.

Conclusions

1. Reasonable feasibility of production of plant-based beverages based on sunflower protein concentrate, which is produced by enterprises of the oil and fat industry of Ukraine.

2. The basic recipes of plant-based drinks have been developed - "Chocolate" drink, "Creamy" flavored drink, "Melon" flavored drink - based on sunflower protein concentrate.

3. The next stages of research are: development of technological parameters for the production of herbal ultra-pasteurized drinks according to the developed recipes; approbation of the developed technology of herbal drinks in laboratory and production conditions; registration of regulatory documentation for the production of plant-based beverages based on sunflower protein concentrate.

REFERENS

1. Ry`nok rosly`nnogo moloka v Ukrayini: dlya ty`x, komu ne potribne poseredny`cztvo korovy` [Elektronny`j resurs]. Rezhy`m dostupu: https://pro-consulting.ua/ua/pressroom/rynok-rastitelnogo-moloka-v-ukraine-dlya-teh-komu-ne-trebuetsya-posrednichestva-korovy. Data zvernennya: 11.06.2021.
2. Biznes-plan proektu vy`robny`cztva rosly`nnogo moloka [Elektronny`j resurs]. Rezhy`m dostupu: // https://pro-consulting.ua/ua/biznes-plan/biznes-plan-proekta-proizvodstva-rastitelnogo-moloka. Data zvernennya: 10.05.2022.
3. Ukrayina perexody`t` na «al`ternaty`vne» moloko? [Elektronny`j resurs]. Rezhy`m dostupu: Derzhstat opry`lyudny`v cikavi dani: https://glavcom.ua/economics/finances/ukrajina-perehodit-na-alternativne-moloko-derzhstat-oprilyudniv-vrazhayuchi-dani-764369.html. Data zvernennya: 17.05.2022.
4. V Ukrayini postupovo rozvy`vayet`sya ry`nok rosly`nnogo moloka [Elektronny`j resurs]. – Rezhy`m dostupu: http://agro-business.com.ua/agrobusiness/item/21968-v-ukraini-postupovo-rozvyvaietsia-rynok-roslynnoho-moloka.html. Data zvernennya: 17.05.2022.

5. Investy`ciyi u vy`robny`cztvo vivsyanogo moloka okuplyat`sya protyagom tr`ox rokiv [Elektronny`j resurs]. Rezhy`m dostupu: https://kurkul.com/news/17763-investitsiyi-u-virobnitstvo-vivsyanogo-moloka-okuplyatsya-protyagom-troh-rokiv. Data zvernennya: 10.05.2022.
6. Vy`robny`cztvo vivsyanogo moloka pry`nese garny`j pry`butok – AgroNews.ua [Elektronny`j resurs]. Rezhy`m dostupu: https://agri-gator.com.ua/2019/05/15/vyrobnytstvo-vivsianoho-moloka-prynese-harnyj-prybutok-agronews-ua/. Data zvernennya: 10.05.2022.
7. Opry`lyudneno rentabel`nist` biznesu z vy`robny`cztva rosly`nnogo moloka [Elektronny`j resurs]. Rezhy`m dostupu: https://agronews.ua/news/169583/. Data zvernennya: 15.05.2022.
8. «Vitmark-Ukrayina» pochav vy`roblyaty` rosly`nne moloko [Elektronny`j resurs]. Rezhy`m dostupu: https://agrotimes.ua/tvarinnitstvo/vitmark-ukrayina-pochav-vyroblyaty-roslynne-moloko/. Data zvernennya: 11.06.2021.

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РОЗРОБКА РЕЦЕПТУР НАПОЇВ РОСЛИННИХ НА ОСНОВІ СОНЯШНИКОВОГО БІЛКОВОГО КОНЦЕНТРАТУ

Анотація

В роботі зазначено фактори, які сприяють розвитку галузі виробництва «рослинного молока» в Україні, наведено аналіз ринку «рослинного молока» в Україні та світі, показано перспективи розвитку даного сегменту протягом найближчого десятиліття у країні, окреслено сегмент українців, які є потенційними споживачами цільового продукту – «рослинного молока». На основі аналізу літературних даних обґрунтовано актуальність та доцільність перероблення концентратів білків соняшника, які сьогодні в Україні виробляють підприємства олійно-жирової галузі, у напої рослинні. Показано перспективність та доцільність застосування наповнювачів – какао-порошку, цукру, натуральних ароматизаторів та барвників, амілолітичних ферментів, згущувачів, спецій (куркума, карі, какао-порошок), регуляторів кислотності – у рецептурах рослинних напоїв на основі концентрату білкового сухого знежиреного соняшникового. Базові рецептури рослинних напоїв були складені на основі аналізу літературних даних щодо хімічного складу молока коров'ячого питного та різних видів існуючого в Україні «рослинного молока» із застосуванням у якості основної сировини концентрату білків соняшника сірого кольору, який виробляє у промислових масштабах український олійно-екстракційний завод №1 ТОВ «Потоки», м. Дніпро. На основі аналізу органолептичних показників рослинних напоїв, вироблених за базовими рецептурами, було обґрунтовано доцільність виробництва іншого виду основної сировини – концентрату білкового сухого знежиреного соняшникового – з покращеними органолептичними показниками, зокрема, з білим кольором. Базове підприємство удосконалило технологію виробництва білкового соняшникового концентрату і лінійка напоїв рослинних була розроблена на основі концентрату білкового сухого знежиреного соняшникового білого кольору. Результатом роботи стали три рецептури напоїв рослинних: напій із ароматизатором «Вершковий», напій із ароматизатором «Диня» та напій «Шоколадний». Проведена органолептична оцінка вироблених за розробленими рецептурами напоїв рослинних засвідчила їх високі сенсорні характеристики.

Ключові слова: напій рослинний, концентрат білків соняшника, наповнювач, ароматизатор, органолептична оцінка, рецептура.

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