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SECTION 3

Science of Commodities and the Technology of Goods

INVESTIGATION OF CONDITIONS FOR PRODUCTION OF HIBISCUS EXTRACTS

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Abstract: Appropriate modes were established to produce water extracts of hibiscus, and their physical and chemical properties studied. The applicability of hibiscus extracts in ice cream production was confirmed.

Key words: hibiscus extracts, anthocyanins, flavonoids, ice cream with vegetal extracts

Introduction

In developing new kinds of ice cream, application of **hibiscus** *(Hibiscus sabdariffa)* inflorescence extracts offers new prospects, being a source of anthocyanins, flavonoids, ascorbic, citric, and malic acids, pectin, as well as vitamins C, B1, B2, PP, K, carotenoids, tocopherols, and salts of iron, manganese, phosphorus, magnesium, and calcium [1].

The content of certain bioactive substances, acids, and polysaccharides is set forth in table 1 [2].

Table 1

Content of Certain Chemical Substances in Hibiscus Inflorescence

Chemical Substance	***Content, in %, on dry basis***
Anthocyanins	4-4.5
Protein	7-9.5
Organic Acids	
Hibiscus (hydroxy-citric acid lactone)	15.0
Malic	2-9
Ascorbic	0.08-0.1
Tartaric	8.0
Citric	15-20
Phenolcarbonic Acids	
O-coumaric	1.5
N-coumaric	0.6
Ferulic	0.24

Polysaccharides	
Water soluble	8.0
Pectin substances	2.5
Hemicellulose	1.0

Anthocyanins contained in hibiscus neutralise free radicals and confer intense red colour to extracts. Pronounced P-vitamin activity is characteristic for flavonoids; they prevent development of varix dilatation and stimulate bile secretion. Organic acids assist digestion and stimulate intestinal motility. C, P, and B-group vitamins strengthen the vascular walls and improve immunity. Phenolcarbonic acids are choleretic and anti-inflammatory agents. Water soluble polysaccharides favour the intestinal microflora. Pectin substances contribute to noxious substance detoxification. [3].

Hibiscus is widely used in food industry to produce wine, marinades, syrups, puddings, jellies, and beverages; yet it has virtually no application in dairy desserts technology [4]. Hibiscus is only used in manufacture of yoghurts and as a flavouring for certain types of milk-based ice cream. No scientific rationale was found by the authors for such technologies [5].

Ice cream technology is rather uniform. The specifics of making certain types of ice cream mainly refer to preparatory stages prior to making mixtures. Tea, chicory, and coffee extracts are either blended to milk based mixtures to produce tea ice cream or used as the core ingredient to produce sorbet or tea ice. Chicory and coffee extracts are obtained at water duties 3:1…5:1 by boiling the vegetable material in water. Further the extracts are filtered and blended to ice cream mixtures at 35…40°C prior to pasteurisation. Tea extracts are prepared at water duty 30:1. Vegetable material is added to boiling water and extracted for up to 30 minutes [6].

Extraction is a rather labour-intensive process which is run on periodical basis in double-wall tanks or in heated boilers. The process parameters of extraction are greatly depending on the type of vegetable raw used. Considering the above, utilisation of hibiscus extract in ice cream production requires additional studies to determine the efficient extraction conditions and a new approach to production and utilisation of extracts.

EXPERIMENTAL PART

The experimental conditions

Vegetable raw material shredded to the average size of 0.2…0.5 cm was used for the studies. Water was used as extracting agent.

The method of investigation

The extraction efficiency was determined using gravimetric method, by the total quantity of dry extracted substances in the extraction sample before and after drying.

The quantity of anthocyanins in the extracts was determined by the optical density of solutions.

The aggregate content of phenol compounds was determined by calorimetric method using the Folin-Denis reagent.

The content of tannin, rutin, quercetin, and vitamin C was determined by titrimetric analysis.

Results and discutions

At stage one appropriate modes were established to obtain hibiscus extracts.

Our prior investigation led us to adopt the following extraction conditions: temperature range, 40 to 100°C; duration range, 10 to 80 minutes; water duty range, 10:1 to 30:1. During extraction the vegetable material was mixed with the solvent at the rate of 75 min^{-1}. Another extraction method enhancing the mass transfer process efficiency consisted in using a vibration extractor [7].

The maximal content of extracted substances in the solvent under the conditions described above is set forth in table 2.

Table 2

Maximal Concentration of Hibiscus Extracted Substances in Extracts Produced by Method One

Water Duty	***Weight Fraction of Dry Extracted Substances, %***			
	40±2 ºC	***60±2 ºC***	***80±2 ºC***	***100±2 ºC***
30:1	1.60±0.04	1.83±0.03	2.03±0.05	2.40±0.06
20:1	2.62±0.06	3.01±0.04	4.02±0.12	4.22±0.12
10:1	3.60±0.10	4.02±0.08	5.63±0.11	5.80±0.14

The advisable extraction time, yielding the samples with the highest concentration of extracted substances, was 40 to 20 minutes for water duties 30:1 and 20:1 and 40 to 30 minutes for 10:1 water duty, with the extraction temperature increased. This effect was due to reduced extraction speed with decreased concentration of the extracted substance found in solid phase and inside the solvent.

The temperature conditions within the range of 80 to 100°C with all water duties ensure 1.5-2 times higher extractive substance content compared to low temperature extraction (40 to 60°C).

It was established that the duration of hibiscus raw material extraction should last up to 40 minutes. Longer process results in condensation and hydrolysis of tannins (table 3).Tannin losses, when the abovementioned duration was exceeded, were 10.4 to 20.9% for 50 to 80 minutes of extraction, accordingly.

Table 3

Tannin content (mg%) in hibiscus extract during extraction
with water duty 10:1 and temperature 100°C

Extraction Duration, minutes	***10***	***20***	***30***	***40***	***50***	***60***	***70***	***80***
Content, mg/%	1.59± 0.04	1.68± 0.05	1.86± 0.06	1.87± 0.04	1.85± 0.04	1.53± 0.04	1.50± 0.03	1.48± 0.04

Such hydrolysis of tannins, as demonstrated for the extract obtained with water duty 10:1 at 100°C, reduced the actual acidity to pH=1.5, which can be possibly explained by accumulation of organic acids and their decomposition products. The data so obtained correlate with the results produced by E.I. Ryabinina during her studies of balm extracts (Melissa officinalis L.) [8].

To establish optimal extraction modes we generated mathematical models using a modified application within the MathCAD environment. The approximation by substituting a certain function f (x, y) with an approximated function φ (x, y) enabled us to determine the functional connection between the dry extract content and the extraction duration (X) and temperature (Y). The third order polynomials serving as mathematical models for extraction at water duties 30:1, 20:1 и 10:1 are as follows:

$$P(X,Y) := -0{,}00000148XY^2 + 0{,}0000016Y^3 - 0{,}000128\,Y^2 + 0{,}01109\,Y + 0{,}0000918\,X\,Y + 0{,}00000073\,X^2\,Y + 0{,}047\,X - 0{,}00086042\,X^2 + 0{,}00000468\,X^3 + 0{,}38044643$$

$$P_1(X,Y) := -0{,}000002385\,X\,Y^2 - 0{,}00003109\,Y^3 + 0{,}00656339\,Y^2 - 0{,}40198036\,Y +$$

$0{,}0001975\ X\ Y + 0{,}00000085\ X^2Y + 0{,}05596892\ X - 0{,}00106969\ X^2 + 0{,}00000577X^3 + 9{,}07433929$

$P_2(X, Y) := 0{,}00000071\ X\ Y^2 - 0{,}000054\ Y^3 + 0{,}0111\ Y^2 - 0{,}686\ Y - 0{,}00008911\ X\ Y - 0{,}00000036\ X^2\ Y + 0{,}1050\ X - 0{,}001986\ X^2 + 0{,}0000123\ X^3 + 15{,}015$

The next stage of our research covered the efficiency of repeated extraction. It was established that, on the average, the first extraction brings into the solvent up to 75 % of water soluble substances; the second, up to 23 %; the third, up to 2 %. Therefore, advisability was confirmed for single and double extraction only.

To determine extraction efficiency for double staged process, a criterion of at least 1% extracted substances concentration in extracts was established. Such quantity of extracted substances corresponds to the minimal requirement for their content in ice cream. Typical sorbet recipes with 74.6-75.0 % extract content require the extractive substance concentration of 1.33-1.34 %, and with 18 to 20 % peak extract content in diary mixes, the extractive substance concentration of at least 5.0-5.5 % will be necessary. We were able to obtain such process efficiency during the first extraction only.

Therefore, the recommended parameters for double extraction to obtain a technologically usable extracts are as follows: water duty, not to exceed 10:1; temperature, ca. 80°C; time, up to 20 minutes.

However, for a more thorough extraction of target components from vegetable material, the authors suggest using a vibration stirring extractor. This device brings the active surface of interacting phases close to 100 %, practically excluding the effect of hard particle mutual screening.

Extraction using the vibration extractor was conducted under the recommended temperatures of 80 and 100°C and various water duties.

The maximal concentrations of extractive substances achieved using a vibration extractor are set forth in table 4.

Table 4

Maximal Concentration of Hibiscus Extracted Substances in Extracts Produced using a Vibration Extractor

Water Duty	***Weight Fraction of Dry Extracted Substances, %***	
	80±2 °C	***100±2 °C***
30:1	3.31±0.08	3.68±0.11
20:1	5.30±0.11	5.51±0.14
10:1	6.52±0.15	7.08±0.18

The utilisation of a vibration extractor increased the extractive substance content 1.2 to 1.6 times, and the extractive substance equilibrium concentration in the solvent was obtained 10 minutes earlier on the average. Thus, utilisation of a vibration extractor is technologically advisable to produce hibiscus water extracts.

Research of the chemical composition and physical properties of hibiscus extracts produced the following results. Hibiscus extracts obtained using the traditional method with 10:1 water duty contain 3,32 mg% of phenol compounds, 13,1 mg% tannins, 1,3 mg% rutin. Nearly the same proportions of the abovementioned substances was characteristic for extract obtained by vibration extractor, safe for a slight increase in tannin content (up to 7%). The peak anthocyanin content in the extracts was at 0.92…1,48 mg%. The initial vitamin C content in dry hibiscus inflorescence being 2,56 mg%, its quantity suffered more than double reduction in extracts. Therefore, vitamin C content is little influenced by the extraction method and temperature.

Now therefore it has been proved that hibiscus extracts are a valuable component for ice cream recipes. Taking into account the excessive acidity of hibiscus extracts, we resolved to blend the hibiscus extract to milk based mixtures chilled to 4…6°C.

No limitations were found for the blending sequence and heat processing of components to produce sorbet.

Test samples of ice cream were produced using a batch action freezer. The freezing time was 5 minutes, and the output temperature for soft ice cream was 4±2 ºC below zero, sorbet, 5±2 ºC. The physical and chemical parameters of milk ice cream and sorbet with hibiscus extracts compared to classical milk ice cream and sorbet are set forth in table 5.

Table 5

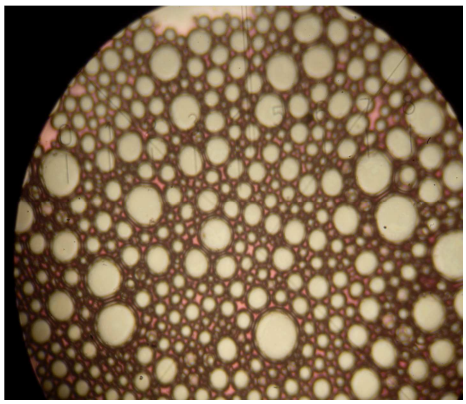
Physical and Chemical Parameters of Milk Ice Cream and Sorbet

Parameter	***Milk Ice Cream***	***Hibiscus Extract Milk Ice Cream***	***Sorbet***	***Hibiscus Extract Sorbet***
Weight fraction of fat, %, at least	3.5	3.5	-	-
Weight fraction of MSNF, %, at least	10.0	10.0	-	-
Weight fraction of extract dry matter, %, at least	-	1.0	-	1.0
Weight fraction of sugar, %, at least	15.5	15.5	25.0	25.0
Weight fraction of dry matter, %, at least	29.0	30.0	25.5	26.5
Actual acidity pH, at least	6.10	4.60	6.48	4.62
Overrun, %	83.6±1.9	92.1±1.6	95.0±2.0	115.3±1.9
Melting resistance, minutes	65,0±1,3	79,0±1,5	40,0±1,7	45,5±1,6
Air bubble average diameter, μm	42,40±0,63	40,56±0,58	60,25±0,87	52,63±0,78

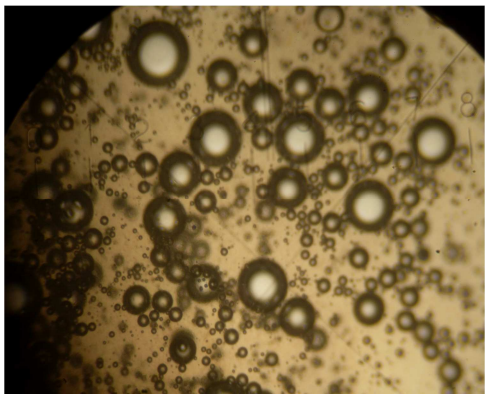
The ice cream and consistency of hibiscus extract milk ice cream was homogenous and creamy; colour: pink; taste: fresh, acidulous, flowery and fruity.

The ice cream and consistency of hibiscus extract sorbet was homogenous and slightly snowy; colour: bright, reddish pink; taste: acidulous, pronounced flowery and fruity.

The microscopic structure of hibiscus extract milk ice cream (a) and classical milk ice cream (b) magnified at 10x16 is presented in **Figure**.



a



b

Fig. Microscopic Structure of Hibiscus Extract Milk Ice Cream (a) and Classical Milk Ice Cream (b)

The analysis of physical and chemical parameters supports the conclusion that hibiscus extract favourably influences sensory parameters of the finished product. Also note certain increase in overrun and melt resistance, as well as a fine air dispersion. This effect can be explained by the addition of polysaccharides making part of hibiscus extract [2, 6].

Therefore, hibiscus extract is a prospective ingredient enabling ice cream production free from colouring and flavouring agents and acidity regulators.

CONCLUSIONS

1 – For traditional method extracts to be used in ice cream production, the recommended modes are: water duty 10:1, temperature 80 to 100°C, duration 30 to 40 minutes. For vibroextraction, the following are required: water duty 10:1 to 20:1, temperature 80 to 100°C, duration 20 to 30 minutes;

2 – Repeated extraction parameters: water duty 10:1, temperature 80 to 100°C, duration at least 10 minutes;

3 - Vibration extractor utilisation increases the extraction substances content 1.2 to 1.6 times;

4 – The minimal content of hibiscus dry extraction substances required to build pronounced colour, flavour, and taste of milk ice cream and sorbet is 1.0% at least;

5 – Hibiscus extracts need to be blended to milk based mixtures at the stage of pre-maturation at 4 to 6°C.

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REFERENCES

[1] Muller B, Franz G. Chemikal structure and biological activity of polysaccharides from Hibiscus sabdariffa. Planta Med 1992; 58:60-7.

[2] http://flowers-home.nm.ru/karkade.htm

[3] Беспальченко Е.А. Тропические декоративные растения – М.: БАО-Пресс, 2006 – 240 с.

[4] Оленев Ю.А., Творогова А.А., Казакова Н.В., Соловьева Л.Н. Справочник по производству мороженого. – М.: ДеЛи принт. – 2004. – 798 с.

[5] Morton J. 1987. Roselle. p.281-286. In: Fruits of warm climates. Julia Morton, Miami, FL.

[6].Типова технологічна інструкція з виробництва морозива молочного, вершкового, пломбір, плодово-ягідного, ароматичного, щербету, льоду, морозива з комбінованим складом сировини. ТТІ 31748658-1-2007 до ДСТУ 4733:2007, 4734:2007, 4735:2007.

[7] Гулак Е.В., Попова Н.В.. Виброэкстрагирование из растительного сырья в технологии мороженого // Пищевые продукты и здоровье человека: материалы IV Всероссийской

конференции с международным участием студентов, аспирантов и молодых ученых.– Кемерово, 2011. – С. 57.
[8] Рябинина Е.И. Исследование процесса экстракции таннинов из MELISSA OFFICINALIS L./ Е.И. Рябинина, Е.Е. Зотова, Н.И. Пономарева, Г.И. Шведов // Современные методы химико-аналитического контроля фармацевтической продукции: метериалы I Всероссийской конференции. Москва: ГК «Измайлово» - 2009. – С. 230-231.