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Section 1. Chemistry

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SYNTHESIS AND STUDY OF THE PROCESSES OF BIOCHEMICAL ACTION OF THE COORDINATION COMPOUND OF COBALATE II-NITRATE WITH QUINAZOLIN-4-ONE, 6-BENZYLAMINOPURINE ON THE MORUS ALBA VARIETY OF MORACEAE PLANTS

G. O. Baymuratova [1]***, G. Sh. Khaydarov*** [2]***, F. E. Saitkulov*** [1]***,***
I. I. Okhunov [3]***, T. U. Eshboboyev*** [1]***, H. M. Nasimov*** [4]

[1] Tashkent State Agrarian University, Uzbekistan

[2] Uzbek-Finnish Pedagogical Institute, Uzbekistan

[3] Kakand State Pedagogical Institute, Uzbekistan

[4] Samarkand State University

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Abstract

In the article, for the first time, the methods of synthesis of coordination compounds of cobalt (II) nitrate with quinazolin-4-one, 6-benzylaminopurine in different proportions are presented. Their formation in the presence of various solvents was shown and analyzed using physical research methods. The biological effect of the synthesized coordination compound on Morus plant was studied.

Keywords: *Quinazolin-4-on, 6-benzilaminopurin, reaction, cobalt (II)-nitrate, coordinate compound, moraceae plant, morus alba, biochemical effect, solvent, root system, development, leaf, photosynthesis, fruit, increase in carbohydrate content, nutrients, temperature, moisture, soil composition*

Introduction

For centuries, trade caravans on a long and dangerous journey from China to the west were scrutinized very carefully. Traders are fined for violating the law, and sometimes all goods are confiscated. Immediately, however, the death penalty awaited everyone trying to carry at least a few yellows, tiny grains, transparent silk wound particles – silkworms like testicles.

Silk served as money in China, producing paper from silk, and writing books before the invention of silk. For 100 years, for example, it was written in the silk classic of the Chinese historian Sima Qian, which consists of 130 chapters (Yurovskaya, M.A., Kurkin, A.V., Lukashev, N.V., 2007; Uwaydah, J.M., Aslam, M., Brown, C.H., Fitzhenry, S.R., Medonough, J.A., 1997; Shakhidoyatov, H.M., 1988; The search for pathogenic pesticides in a number of 2-thioxoquinazolinov-4, 1982; Kalinin, F.L., Merezhinsky, Yu.G., 1965; Sapaev, B. et al., 2021; Saitkulov, F.E. et al., 2014; Sapaev, B. et al., 2022; Saitkulov, F. et al., 2023; Saitkulov, F. et al., 2022).

With long and great profits, China was sold to the West with the oldest most expensive and luxurious fabrics-silk. They were regularly shipped in large quantities to the Mediterranean coast, and yet production remained a mystery to the Europeans for a long time. According to the ancient Chinese philosopher Confucius, the Chinese were well versed in silkworm breeding 3,000 years ago. China's neighbors, and even loved ones like Korea and Japan, have only known the secrets of this product for centuries. For centuries, China has kept the secret of silk production, which has led fans astray. In Greece and Rome, for example, silk was believed to have been made from the lower part of birds living in high mountain trees that were almost inaccessible.

Despite the fact that the Mulberry treeng Root is very well developed, this plant is a very demanding plant for nutrients, temperature, moisture, soil composition.

So, despite the fact that the root system of the mulberry tree is developed, the more abundant and qualitative leaf mass, and in order to increase the amount of Hydrocarbons contained in the fruit, the incense must be formed on fertile, soft-grained land (Saitkulov, F. et al., 2022; Saitkulov, F. et al., 2022; Saitkulov, F. et al., 2022; Saitkulov, F. et al., 2022; Alafeefy, A.M. 2011; Navneet Singh., Agarwal, R.C., Singh, C.P., 2013; Khodjaniyazov, Kh.U., Mamadrahimov, A.A., 2017; Byr'ko, V.M., 1984; Blokh, G.A., 1972; Koval', I.V., Usp. Khim., 1996; Brauer, G., Ed. 1963).

Most of the lands of Central Asia consist of Sandy and Sandy (Karakum, Kyzyl-Kum, Karshi steppes) soils, which well conduct water, heat and air from themselves, but can't retain moisture and nutrients in themselves. The main reason for this can be observed that the amount of humus in the soil is very small, that is, around 0,2–0,5%, the thickness of the humus layer does not exceed several centimeters. Therefore, in such soils, the mulberry tree grows very poorly (Smith, G.E.P., Alliger, G., Carr, E.L., and Young, K.C., J. Org. Chem., 1949; Schwarzenbach, G. and Flashka, H., 1970; Klimova, V.A., 1975; Kalinnikov, V.T. and Rakitin, Yu.V., 1980; Rao, C.N.R. and Venkataraghavan, R., 1962; Jensen, K.A. and Nielssen, P.H., 1966; Daescu, C., Bacaloglu, R., and Ostrogovich, G., 1973; Nakamoto, K., 1991).

It should also be noted that the application of such measures as timely processing of the tree row-to-row in mulberry and the correct path of watering is of great importance in increasing the fertility of the soil, so it is necessary to ensure that between the row-to-row of mulberries and sowing, as well as planting lands are plowed in autumn, in order for this to not happen, the incense should be watered by grinding the owners.

If we compare the reproduction of shrubs with seeds and vegetative ways in order to increase the yield of Mulberry, then in the first years of use, it is possible to make sure that in the first case, the increase in productivity is different in different environments. While it is possible to observe that the Leaf yield growth in the Bush mulberry, which is grown from Sprouts, is very sluggish, while in the Bush mulberry, which has its own roots, it was observed that the use of the Leaf sharply increases the yield in the second year, in other words, the yield of the second year leaf from the In the Bush mulberries with an acre root, the range of plants in the range of 3 meters in a row was 0,5 meters, while the number of Bush mulberries in each hectare was 3700 units, in the second year after planting from cuttings in the first year of using mulberry leaves, the yield of leaves per hectare was 2,8–3,0 tons, It can be seen that in the third year of use of mulberries, the Leaf yield obtained from Mulberry was observed in the fourth year in a permanent place in the seed – recovered mulberries, the mass of the Leaf was 2–3 tons more than in the first year, which indicates that the yield was 2,0–2,5 times higher than the (Geary' W.J.

1971; Grand' A.F. and Tamres', M. 1969; Lever, A.B.P. 1987).

The data on the development of the root system, photosynthesis in the leaves, methods of increasing the hydrocarbons content in the fruit, with the participation of various concentrated solutions of biochemical action processes of the coordination compound synthesized in the "morus alba" variety of the Moraceae plant of Mulberry, continue their scientific work in this area.

Experimental part

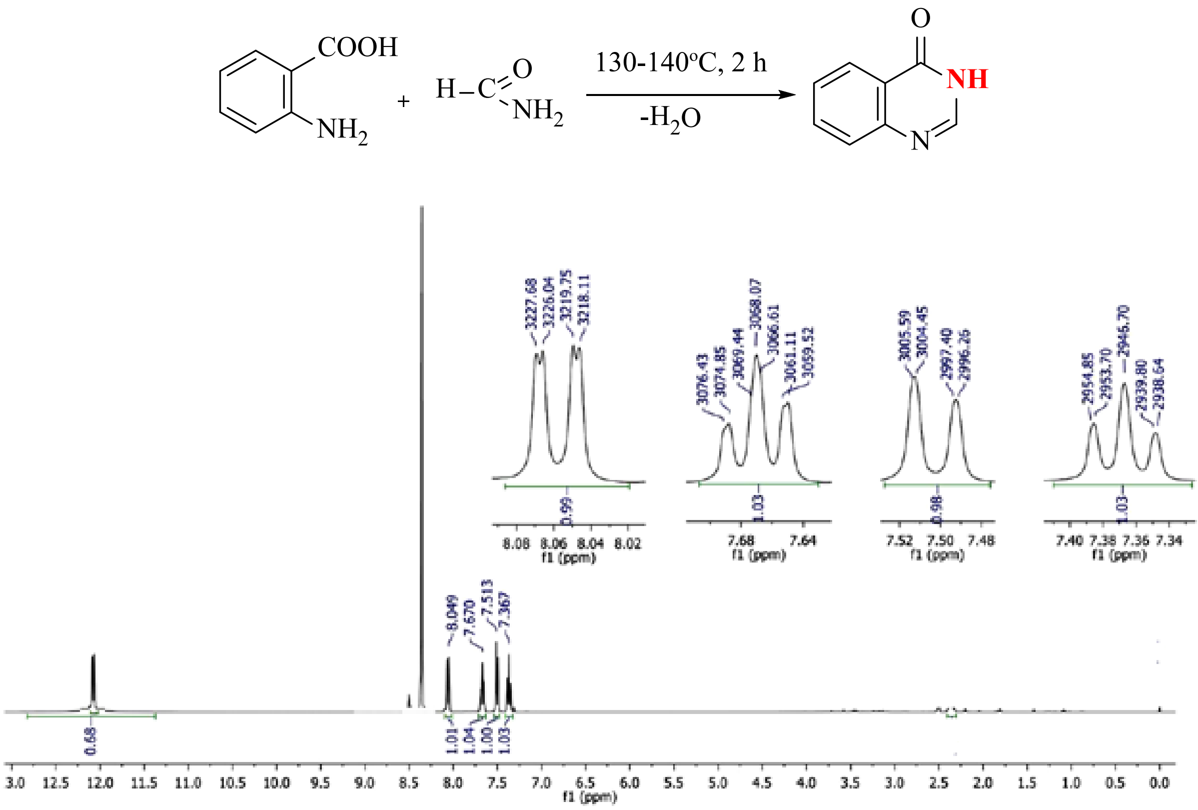
Synthesis of quinazolin-4-one. Method A. From the literature there are many works on the synthesis of quinazolines and its derivatives (Weisberger, A., Proskauer, E., Riddik, J., and Tups, E. (1985; Smith, G.E.P., Alliger, G., Carr, E.L., and Young, K.C., J. Org. Chem. 1949).

We also carried out the synthesis of quinazolin-4-one in two different ways.

Method: A. Experiments were carried out in a reaction chamber flask with a volume of 100 ml equipped with reflux refrigerator. To obtain the substance quinazolin-4-one, add 13.7 g (0.1 mol) anthranilic acid 16 ml of formamide was added (ρ = 1.42 g/cm^3). The reaction mixture was heated to the levels indicated in Table 2 temperatures and kept for a specified time. Then the reaction mixture poured into a glass containing crushed ice and left for 6–8 hours at room temperature. Dropped Crystals filtered and dried. The output was 13.8 g quinazolin-4-one. Product further purified by recrystallization in water in the presence of activated carbon. Exit the purified substance was 12.87 g (88.17%). T. = 217–218 °C. (Saitkulov, F. et al., 2022; Alafeefy, A.M., 2011; Navneet Singh, Agarwal, R.C., Singh, C.P., 2013; Khodjaniyazov, Kh.U., Mamadrahimov, A.A., 2017; Byr'ko, V.M., 1984; Blokh, G.A., 1972; Koval', I.V., Usp. Khim., 1996).

Method: B. Boil a solution of 4 ml (0.1 mol) formic acid and 5 ml (0.1 mol) ammonia (25%) in a water bath for 1 hour. Then 13.7 g (0.1 mol) was added to the reaction mixture anthranilic acid was continued to boil in for 5 hours. The gray sediment was washed acetone and dried. Recrystallized from water with activated carbon. Got white the color precipitate was dried. Yield: 7.8 g (53%), m.p. = 216–218 °C.

Figure 1. *^{1}H NMR spectra quyinazolin-4-on*



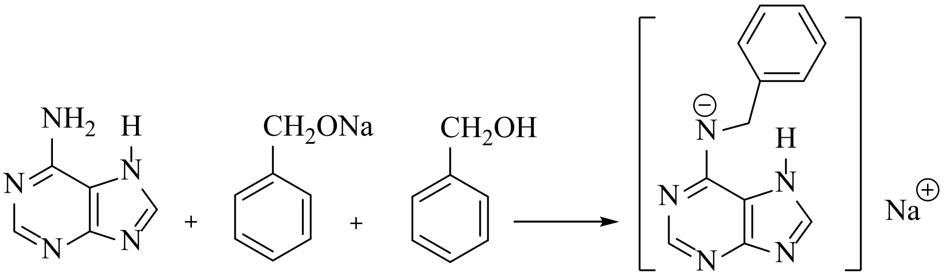
Melting point of quinazolin-4-one determined on a heating table "BOETIUS" (Germany).

Product purity and reaction progress controlled by TLC Silufol UV-254. (chloroform: benzene: methanol system 5 : 3 : 1) $R_f = 0.61$. IR spectra were recorded on an IR spectrometer -Fourier system 2000 in KBr tablets 1H NMR spectra were recorded on a Unity instrument 400^+ (operating frequency 400 MHz, internal TMS standard, scale δ) solvent CD3COOD+HMDSO.

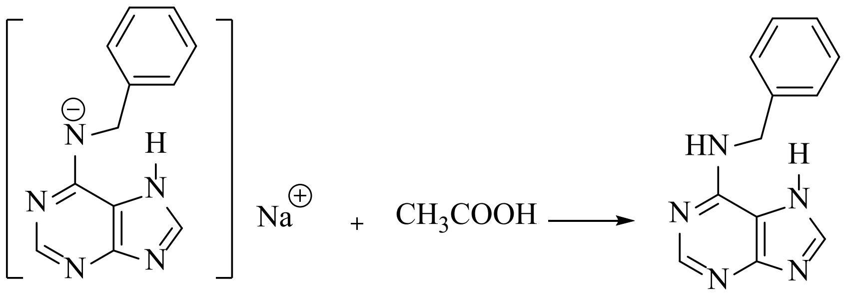
Mass spectrometry results with electrospray ionization (ESI–MS) recorded using a 6420 Triple Quad LC/MS mass spectrometer (Agilent Technologies, USA) (Brauer, G., Ed. 1963).

The chemical reaction of the process is carried out as follows.

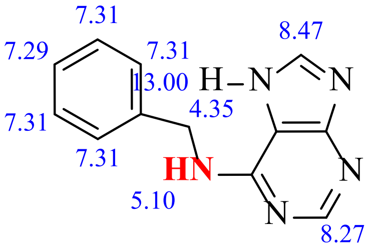
Synthesis of 6-benzylaminopurine. Adenine of sodium benzylate, and benzyl alcohol were added to the flask (the molar ratio of adenine, sodium benzylate, benzyl alcohol is and with stirring boiled for 2.5 hours. Cooled to room temperature, 150 ml of diethyl ether was added and the precipitate was filtered. Sodium salt of 6-benzylaminopurine was obtained, the yield was 94%.



Sodium salt of 6-benzylaminopurine was dissolved in 150–200 ml of hot water, 1.3–1.5 ml of acetic acid was added to pH 6.5–7.5, cooled to room temperature and filtered, dried.

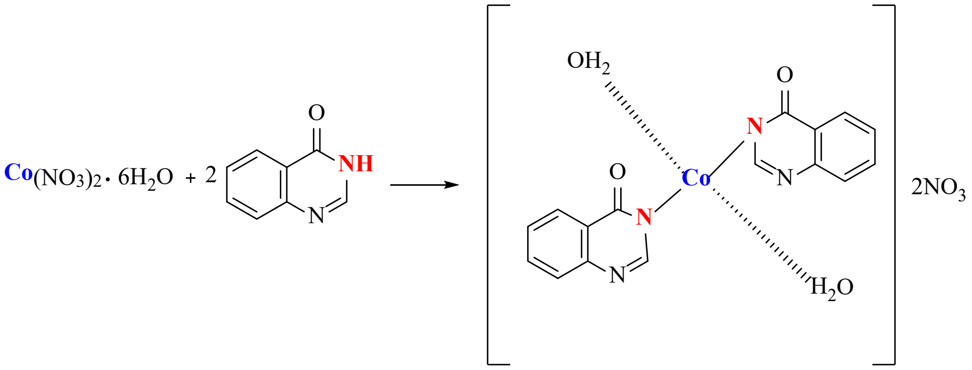


When the structure of 6-benzylaminopurine molecule was analyzed by 1H NMR spectrum, it was found that the molecular bonds are as follows.

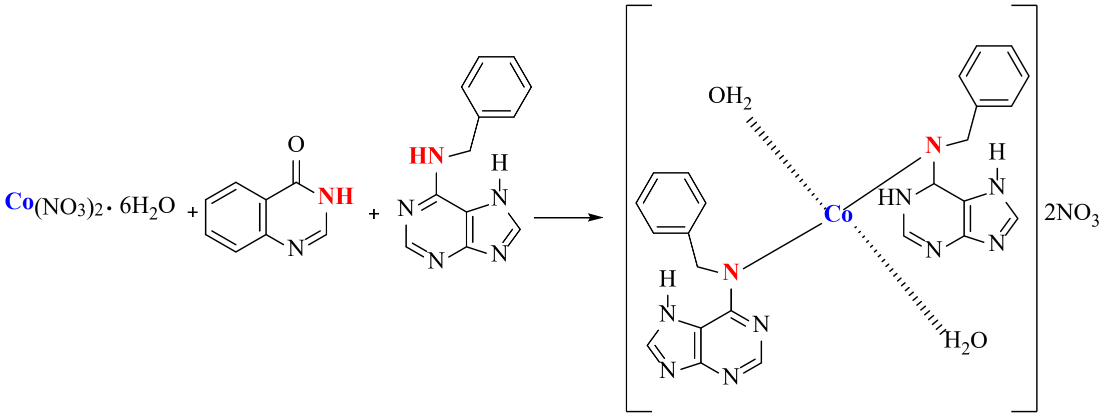


Synthesis of quinazolin-4-one coordination compound with cobalt (II)-nitrate hexahydrin

To 0.01 mol of cobalt (II) nitrate hexahydrate dissolved in 20 ml of boiled ethyl alcohol, 0.02 mol of quinazolin-4-one dissolved in 25 ml of ethyl alcohol was added. The solution was stirred for 50 minutes. The solution was kept in the cold for some time, then the white precipitate that formed was filtered off, washed with water and then with alcohol. Dried in a desiccator over sulfuric acid until constant weight was established.

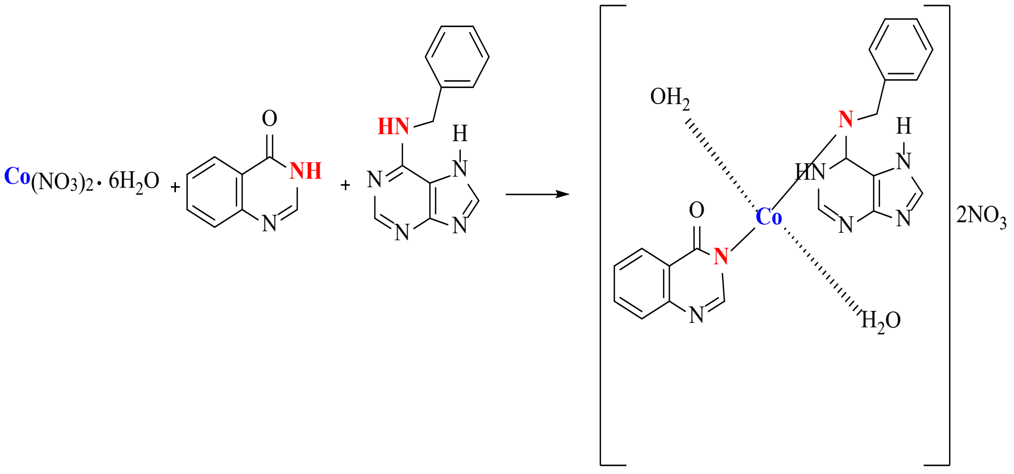


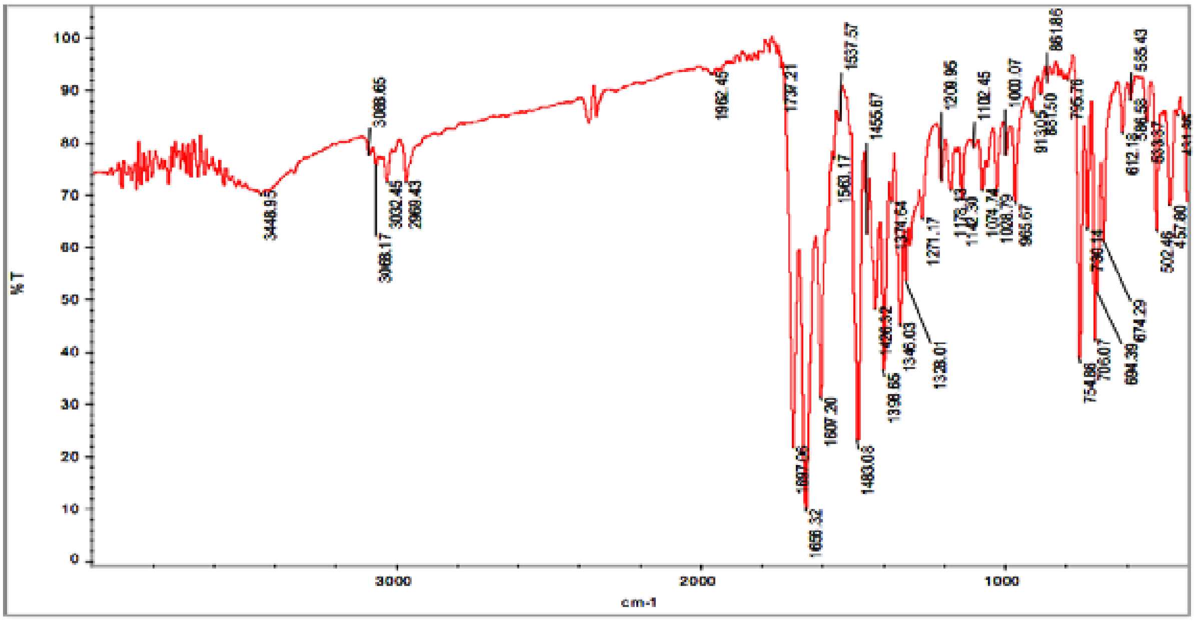
Synthesis of 6-benzylaminopurine coordination compound with cobalt (II)-nitrate hexahydrin. 0.01 mol of cobalt-(II) nitrates were dissolved in 30 ml of a mixture of methyl alcohol and triethyl orthoformate (1:1). The resulting solution was added to a solution of 0.02 mol of 6-benzylaminopurine in 30 ml of a mixture of the same solvents. The reaction mixture was stirred for 50 min until the solvent boiled. The resulting complexes were separated by filtration, washed with diethyl ether and dried.



Synthesis of quinazolin-4-one and 6-benzylaminopurine coordination compound with cobalt (II)-nitrate hexahydrin. 0.01 mol of cobalt-(II) nitrate hexahydrate dissolved in 20 ml of boiled ethyl alcohol, 0.01 mol of quinazolin-4-one and 0.01 mol of 6-benzylaminopurine dissolved in 25 ml of ethyl alcohol were added. The solution was stirred for 50 minutes. The solution was kept in the cold for some time, then the white precipitate that formed was filtered off, washed with water and then with alcohol. Dried in a desiccator over sulfuric acid until constant weight was established.

Figure 2. *IR spectrum coordination compounds salt cobalt.*





By reacting solutions of ligands with the corresponding metal nitrates in the molar ratio M: L 1:2, 1:1:1, complexes with a common value for all synthesized ones were obtained. Compounds of the formula ML2X2, where: M – Co; L-quinazolin-4-one, 6-benzylaminopurine; X-NO_3-.

Analysis of the IR spectrum of the complex showed that quinazolin-4-one, 6-benzylaminopurine is coordinated. This conclusion was made based on the finding in the IR spectrum of the complex of new absorption bands at 1386 cm^{-1}, absent in the spectrum of the free ligand.

In addition, a new band at 827 cm^{-1} that appeared in the IR spectrum of the complex is attributed to out-of-plane bending vibrations of the coordinated nitrate group. As mentioned above, according to coordination, the stretching vibrations of this group should split into two bands. The bands at 1473 and 1278 cm^{-1} found in the IR spectrum of the complex also indicate that the nitrate ligand is outer spheral.

To complement the results obtained by IR spectroscopy, an NMR spectroscopic study of the structure of the synthesized diamagnetic cobalt complexes was carried out. PMR spectra of nitrate complexes are slightly different from the PMR spectrum free ligand. In the NMR spectrum of the complexes, all signals of hydrogen-containing functional groups are slightly shifted to the weak field region compared to their location in the NMR spectrum of the ligand, which indicates an ongoing reaction complexation. In the NMR spectrum of the $Co(NO_3)_2L2{\cdot}H_2O$ complex, the doublet-doublet signals of the protons of the benzene ring are shifted to the weak field region and have centers at δ 7.32 and 7.84 ppm. In the 1H NMR spectrum of the $Co(NO_3)_2$ complex in the high field region at δ 1.90–1.94 ppm. a singlet signal is observed. Shift of all signals responsible for hydrogen-containing functional groups in the ligand molecule to the weak region fields, as well as the appearance of a new signal from protons quinazolin-4-one, 6-benzylaminopurine indicates coordination to the complexing ion. Results of PMR spectroscopic study the structures of the synthesized complexes confirmed the previously obtained conclusions using IR spectroscopy about the location of acid ligands in the internal sphere of the complex соединения.

Results analysis

Kobalt (II)-nitrate and quinazolin-4-on, 6-benziaminopurin in the study of biochemical action processes on the “Morus alba” varieties of the Moraceae plant of the coordination compound formed by fatty acid, the following processes were carried out. In previous scientific works, one-year herbs, “Kahraba” variety of Phaseolus aureus plant belonging to the family of legumes, as well as the processes affecting the root-throwing system of the goose “Bukhara-102”, “Namangan-77", "Sultan", "Onkurgan-1", "C-6524" varieties are also studied.

In order to carry out the processes of biochemical action on the "Morus alba" varieties of the Moraceae plant, cobalt (II)-nitrate and quinazolin-4-on 6-benziaminopurin a coordination compound formed by fatty acid dissolved in the Absolut ethyl alcohol so that it does not decompose into ions, we prepared the necessary solution, then 200 milliliters 5% and 200 milliliters 10% increments were prepared.

The results obtained from the conducted experiments are as follows.

1. As a result of the experiment, 5% and 10% solutions of the II product were prepared in distilled water.

2. The root of the one-year plant variety "Morus alba" of 4 Moraceae plants was dipped in a 5% solution for 5 hours.

3. The root of the one-year plant variety "Morus alba" of 4 Moraceae plants was dipped in 10% li solution for 5 hours, and the root of the one-year plant variety "Morus alba" of another Moraceae plant was dipped in ordinary water for 5 hours.

The effect of cobalt (II)-nitrate and quinazolin-4-on, 6-benziaminopurin coordination compound formed by fatty acid on root growth was studied.

One-year plant varieties of the Morus alba plant of the Moraceae plant were transferred to the canvases (total 9 pots), watered every morning at 8–00 hours.

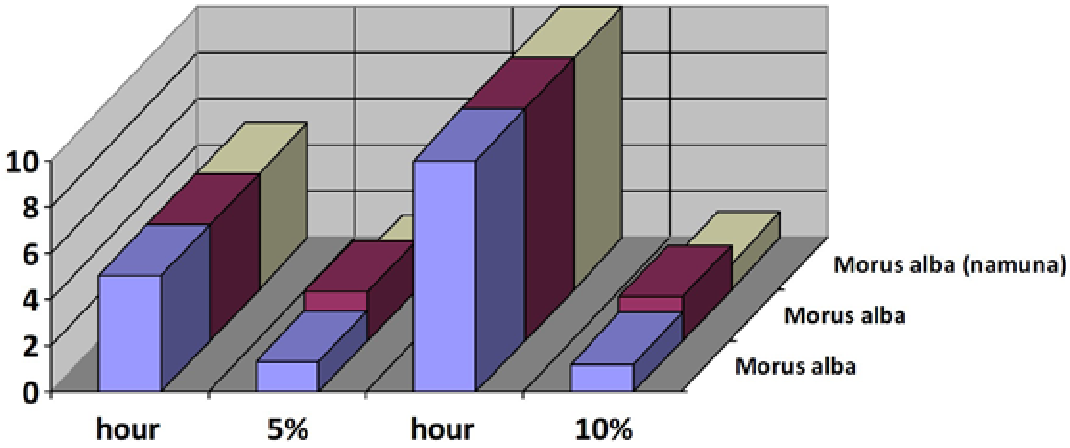
Moraceae plant "Morus alba", immersed in the root in a solution of 5% for 10 hours, is faster to form a leaf than the annual plant variety 5 hours, and the length of the rod in the plants was carried out in the same sequence.

It can be concluded that if the roots are dipped for 5 hours in a 10% solution compared to a 5% solution with an increase in the rate of growth of the root, it is desirable to count.

Table 1. *The effect of coordination compound of quinazolin-4-one with 6-benziaminopurin on Morus alba plant is described in table-1 below*

№	Plant name	hour	5% root length, cm	hour	10% 5% root length, cm
1	Morus alba	5	1.3	10	1.2
2	Morus alba	5	2.1	10	1.9
3	Morus Alba (namuna)	5	1	10	1.1

Diagram 1. *The effect of the coordination compound of quinazolin-4-one with 6-benziaminopurin on the Morus alba plant is shown in diagram-1 below*



Conclusion

So this complex organic compound plays an important role in the processes of hemopoiesis. Cobalt in plants is a microelement necessary for the assimilation of molecular nitrogen, promotes the formation of nodular bacteria in the root system of leguminous crops.

Cobalamin, also known as vitamin B_{12}, is well soluble in water, vitamin-related metabolism is of great importance in biochemical processes in every cell of the body of man, animal, ossicles.

Vitamins of the Group "B" are the largest and most complex vitamins in terms of composition. Cyanocobalamin and Hydroxocobalamin are used to prevent or treat vitamin deficiency. After assimilation into the body, they are converted into adenosylcobalamin and methylcobalamin, these compounds are important metabolites processes. All forms of vitamins of the Group " B " are a complex macrocyclic compound, biochemically occupying microelements in its composition, among these vitamins is the central atomic cobalt (II)-valence cation in the composition of vitamin B_{12}, as well as regulating metabolic processes.

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Contact: fsaitkulov@bk.ru

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REACTIONS OF N-CHLOROACETYLATION OF TOLUIDINE ISOMERS

Bobonazarova Sarvinoz Habibullaevna [1]***, Abdushukurov Anvar Kabirovich*** [1]***, Yusufov Mukhriddin Saidovich*** [1]***, Islamova Yulduz Oralovna*** [1]***, Azimova Gulmira Zainuddinovna*** [1]***, Abdujabborova Obida Orifovna*** [1]

[1] National University of Uzbekistan, Tashkent

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Abstract

The results of the study of reactions of N-chloroacetylation of toluidine isomers are presented in the article. Methods for purification of reaction products have been developed. Structure of the obtained compounds has been confirmed by means of 1H and 13C NMR spectroscopy.

Keyword: *N-chloroacetylation, chloroacetyl chloride, o-, m-, p-toluidine, 2-chloro-N-tolyl acetamide, acetonitrile, acetone, ethylacetates*

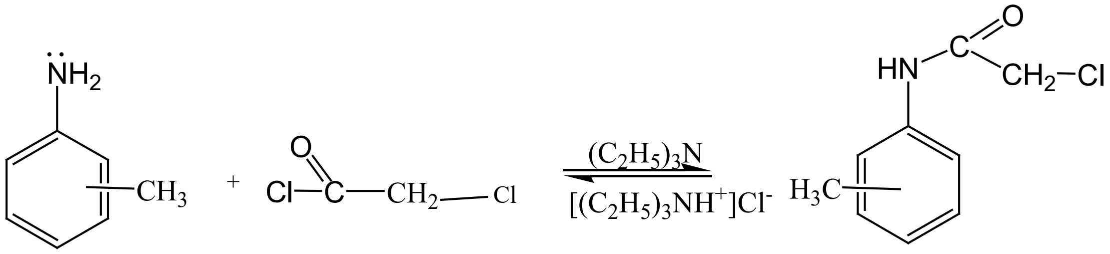
Introduction

Many biologically active substances have been synthesized on the basis of chloracetylation reactions of amino compounds and are widely used in medicine today. Currently, the study of the structure of amide bonds between amino acids reveals new methods for the synthesis of new peptides and proteins, which are an integral part of biology and medicine. It is known that more than 50% of all medicinal substances contain amide bonds. Amide bonds are formed by N-acylation reactions. Acid chloride anhydrides are one of the most widely used N-acylating agents for the formation of amide bonds and are used industrially throughout the world. When chloroacetyl chloride is used as an acylating agent, the reactions proceed under mild conditions and allow obtaining chloroacetyl products in high yields. Because, on the one hand, most of the compounds containing chloroacetyl group have high biological activity, on the other hand, chloroacetyl chloride is a strong acylating agent. The reason is that due to the negative inductive effect of the chlorine atom in chloroacetyl chloride, the carbon atom in the carbonyl group has an additional positive charge and facilitates the progress of the nucleophilic substitution reaction. N-aryl 2-chloroacetamides are used as herbicides, antimicrobials, antifungals, disinfectants (Manuri Brahmayyaa, Shing-Yi Suena, Shenghong A. Dai, 2017. P. 1–2). In addition, carbonic acid amides and their derivatives are used in medicine as antidepressants. Currently, paracetamol, phenacetin and filament are widely used in modern medicine. The main active fragment of these drugs is acrylamides of aromatic carboxylic acids. Expanding research work, new amides, including p-toluidine glycolate and

2-hydroxy-N-(4-methyl) phenylacetamide, are synthesized based on N-hydroxyacetylation of p-toluidine (Joris Hulsbosch, Laurens Claes, Dirk E. D eVos. 2018. P. 1646–1650; Koula, D.O.U.K.A.N.I., Nacera, G.A.C.E.M. and Hayat, B.E.N.L.A.R.B.I.. 2014. P. 1–16). It is known from the literature that acylation reactions of aromatic amines with halogen anhydrides are carried out at low temperatures, otherwise, due to the release of a large amount of heat in the reaction mixture, the mixture of oxidation and polymerization products sinks to the bottom of the vessel in the form of resin, the reason for which is explained by the easy access of the amino group to acylation reactions. Therefore, reagents for N-chloroacetylation reactions of aniline were obtained in the same molar ratio and carried out at a temperature below –20 C (Yusufov M.S., Abdushukurov A.K., 2020. P. 74–75; Yusufov M.S., Abdushukurov A.K., Akhmedova N.B., Yazilova G.M., 2018. P. 159–161). Currently, benzimidazole and benzoxazole derivatives are of great interest to pharmaceutical experts, since they are inhibitors of fructose-1,6-bisphosphatases in the condensation reactions of benzoxazoles with benzenesulfonamide, in which they have good pharmacokinetic activity (Lai C., Rebecca J., Daly M., Fry E., Hutchins C., Abad-Zapatero C., P. 1807–1810), and they are also inhibitors of amyloxygenases is considered (Neochoritis C., Zarganes-Tzitzikas T., Tsoleridis C., Stephanidou-Stephanatou J., Kontogiorgis C., Hadjipavlou-Litina D., Choli-Papadopoulou T., P. 297–306). In addition, many member derivatives of benzimidazole exhibit antibacterial and antimicrobial activity. Their use as a substrate of diazonium salts, a derivative of aminophenylbenzoxazole, increases the anti-inflammatory properties of the drugs (Carella A., Centore R., Sirigu A., Tuzi A., Quatela A., Schutzmann S., Casalboni M. 2004. P. 1948–1954). Experiments carried out in this field in our country and abroad show that it is possible to recommend synthesis of new organic substances and intermediate compounds with high biological activity based on reactions of chloroacetylation of aromatic hydrocarbons, as well as for use in the national economy and medicine.

Results and discussion:

To achieve these goals, chloroacetylation reactions of toluidine isomers were studied. In the literature, it was found that N-acyl products are formed when there are 1:1 molar ratios of reagents (Yusufov M.S., Abdushukurov A.K., 2020. P. 236–237).



The results of the reactions are presented in the table below.

Table 1. *Effect of solvent and time on reactions of chloroacetyl chloride with toluidine isomers to obtain 2-chloro-N-o-, m-, p-tolylacetamides:*

Name of reagents	Mole ratios of reagents	Temperature, °C	Duration of reaction, hours	Solvent	Yeild, %	Product T(liquid)	Rf
Chloro acetyl chloride: o-toluidine: TEA	1:1:1	2–5	6	Acetonitrile	83	106	0.65
				Benzene	78		
Chloroacetyl chloride: m-toluidine: TEA	1:1:1	–2–5	6	Acetonitrile	85	183	0.62
				Benzene	79		
Chloroacetyl chloride: p-toluidine: TEA	1:1:1	–2–5	6	Acetonitrile	88	175	0,73
				Benzene	79		

Toluidine isomers are more nucleophilic than aniline because the presence of an electron-donating (CH_3) substituent on the aromatic ring increases the nucleophilicity of the amino group on the aromatic ring and the chloroacetylation reaction proceeds better. In order to synthesize biologically active substances, N-chloroacetylation reactions of toluidine isomers were carried out under different conditions, and this reaction proceeds as follows.

Table 2. *Results obtained under ultrasonic conditions of chloroacetyl chloride with toluidine isomers:*

Name of reagents	Mole ratios of reagents	Temperature,°C	Dura tion of reaction, hours	Solvent	Yeild, %	Product T(liquid)	Rf
Chloro acetyl chloride: o-toluidine: TEA	1:1:1	–2–5	1	Acetonitrile	88	106	0,65
				Benzene	86		
Chloroacetyl chloride: m-toluidine: TEA	1:1:1	–2–5	1	Acetonitrile	90	183	0,62
				Benzene	85		
Chloroacetyl chloride: p-toluidine: TEA	1:1:1	–2–5	1	Acetonitrile	91	175	0,73
				Benzene	87		

Polar and non-polar solvents were used for the reaction, and in order to reduce the duration of the reaction, it was carried out in an ultrasonic device and optimal conditions were selected.

Experimental part: 0.0214 g (0.0001 mol) of o-toluidine and 0.0338 ml (0.0001 mol) of triethylamine were placed in a round bottomed flask and dissolved in 10 ml of acetonitrile. In the second bowl, 0.02712 g (0.0001 mol) of chloroacetyl chloride was also dissolved in 5 ml of acetonitrile. Then, the reaction mixture in the first bowl was added dropwise to the reaction mixture in the second bowl while cooling (–2–5 °C) and stirring. Cooling stopped. The reaction was stirred at room temperature for 6 h. The formation of new substance in the reaction was monitored by chromatography every hour. A hexane: ethyl acetate ratio of 10:1 was used for this purpose. The solvent was evaporated in a rotary evaporator and the resulting reaction mixture was recrystallized from an organic solvent.

In order to reduce the duration of the reaction and increase the yield of the reaction, without changing the mole ratio, the solutions were added dropwise while stirring at –2–5 °C and carried out in an ultrasonic device at room temperature. The reaction product was monitored every 15 minutes by thin layer chromatography (TLC) for the formation of the N-acyl product. The duration of the reaction was 1 hour. Reactions carried out in an ultrasonic device were chosen as optimal conditions. Acetonitrile and benzene were chosen as solvents for the reactions.

The advantage of this method over the above method is the difference in time, and it is possible to obtain a product with a high yield in a short period of time.

I. Synthesis of 2-Chloro-N-(o-tolyl)-acetamide: The obtained 2-chloro-N-o-tolylacetamide amide melting point and Rf values were determined. Yield 3.07 g (85%). mp 105–106^{0}C., Rf=0,65 1H and 13C NMR were recorded on a JNM-ECZ400R spectrometer (JEOL, Japan) at an operating frequency of 400 MHz for 1H in CD_3OD solutions.d 2.24 (s, 3H, CH3), 4.17 (s, 2H, CH2), 6.95 (d, 2H, H-Ar), 6.85 (d, 2H, H-Ar), 9.9 (s, 1H, NH); 13C NMR spektrum (CD_3OD) 400 MHz 163.86, 135.1, 134.2, 129.7, 120.3, 42.66, 21.0; IR spectra were recorded on an FT-IR/NIR Spectrum 3 spectrometer (Perkin Elmer, Switzerland) using an ATR system. (KBr) ν/cm^{-1}, 3254- (NH), 3134, 3089 (CHAr.), 2953 (CH_2Alip.), 1671 (C=O), 1552 (C=CAr.), 1253 (C–Cl), 864 (CHAr.), 505 (C–CAr.),

II. Synthesis of 2-Chloro-N-(m-tolyl)-acetamide: The obtained 2-chloro-N-m-tolylacetamide amide melting point and Rf values were determined. mp 183–185 °C, Yield 2.88 g. (83%). Rf=0,62. 1H and 13C NMR were recorded on a JNM-ECZ400R spectrometer (JEOL, Japan) at an operating frequency of 400 MHz for 1H in CD_3OD solutions.d 2.19 (s, 3H, CH3), 6.35 (s, 2H, CH2), 6.68 (d, 2H, H-Ar), 10.41 (s, 1H, NH); 13C NMR spektrum (CD_3OD) 400 MHz 162.84, 135.1, 134.2, 129.7, 120.3, 42.66, 21.0; IR spectra were recorded on an FT-IR/NIR Spectrum 3 spectrometer (Perkin Elmer, Switzerland) using an ATR system. (KBr) ν/cm^{-1}, 3253 (NH), 3134, 3091 (CHAr.), 2853 (CHAlip.), 1674 (C=O), 1616 (C=CAr.), 1252 (C–Cl), 864 (CHAr.), 505 (C–CAr.).

III. Synthesis of 2-chloro-N-(p-tolyl)-acetamide. The obtained 2-chloro-N-p-tolylacetamide amide melting point and Rf values were determined. mp 174–175 °C; Yield –3.17 g (88%) Rf=0,73 1H and 13C NMR were recorded on a JNM-ECZ400R spectrometer (JEOL, Japan) at an operating frequency of 400 MHz for 1H in CD3OD solutions.d 2.33 (s, 3H, CH3), 4.17 (s, 2H, CH2), 7.15 (d, 2H, H-Ar), 7.42 (d, 2H, H-Ar), 8.21 (s, 1H, NH); 13C NMR (50 MHz), 163.86, 135.1, 134.2, 129.7, 120.3, 42.66, 21.0; IR spectra were recorded on an FT-IR/NIR Spectrum 3 spectrometer (Perkin Elmer, Switzerland) using an ATR system. (KBr) ν/cm^{-1} 3307, 3203 (NH), 3134, 3089 (CHAr.), 2953 (CHAlip.), 1674 (C=O), 1552 (C=CAr.), 1292, 1252 (C––Cl), 748 (NH), 505 (C–CAr.).

Conclusion

2-chloro-N-(o-tolyl)-acetamide, 2-chloro-N-(m-tolyl)-acetamide, 2-chloro-N-(p-tolyl)-acetamide synthesized from toluidine isomers as chloroacetylation products. The effect of solvent and time on the reaction yield was investigated and the optimum conditions were found. Methods of purification of the obtained substances were determined. The structure of the substances was confirmed by IR and PMR sectors.

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Contact: Bobnazarovasarvinoz7 @gmail.com

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STUDY OF AMINO-CONTAINING COMPOUNDS. ACID CORROSION INHIBITORS AND PRODUCTS OF THEIR DESTRUCTION DURING THE ABSORPTION PROCESS

***Mukhtor J. Makhmudov* [1], *Sherdil A. Rizayev* [2]**

[1] Bukhara Institute of Engineering and Technology. Bukhara. Republic of Uzbekistan

[2] Karshi Engineering Economics Institute. Karshi. Republic of Uzbekistan

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Abstract

Foaming of alkanolamine solutions is one of the main problems in the operation of installations for the purification of hydrocarbons and process liquids from acid gases. Foaming occurs most often in absorbers. less often in desorbers and manifests itself in a sharp increase in the volume of foam on the contact plates. an increase in the pressure drop in the apparatus. the appearance of liquFid level in the purified or acid gas separator. The consequence of this is increased entrainment of the absorbent with gas and a decrease in the gas productivity of the installation. The purpose of this work was to assess the reactivity of compounds containing DEA. acid corrosion inhibitors.

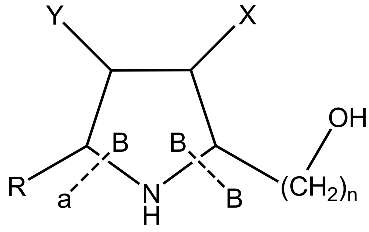
Keywords: *gas. absorption. desorption. amines. oxides. water. corrosion. quantum chemical calculations. infrared spectroscopy*

Introduction

The main reason for foaming. according to many researchers. is the result of the action of impurities that enter the absorber with gas. such as hydrocarbon condensate. formation water. sand. scale. iron sulfides. some corrosion inhibitors. and various surfactants. In this case. the effect of some impurities is manifested in an increase in the volume (height) of the absorbent foam (hydrocarbons); the action of others is to impart stability and rigidity to the foam (solid impurities); thirdly. in increasing the volume and stability of the foam at the same time (surfactants. corrosion inhibitors such as “Visco”) (Attia N. F.. Jung M.. Park J.. Jang H.. Lee K.. Oh H.. 2020). We conducted studies during which it was revealed that iron sulfides and sand do not cause foaming of amine solutions. unlike acid corrosion inhibitors (ACI) and their decomposition products. which are polar substances and strong foaming agents. Process fluids contain a large number of ACI decomposition products that can interact with each other and with incoming (or escaping) gases (Cong Wang. Wenbo Jiang.

Guancong Jiang. Tonghuan Zhang. Kui He. Liwen Mu. Jiahua Zhu. Dechun Huang. Hongliang Qian. Xiaohua Lu.. 2023).

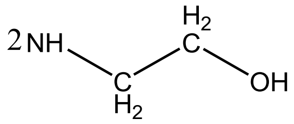
Gas condensate (GC) is an aggressive acidic environment. contains hydrocarbons. H_2S. CO_2. mercaptans. etc. During the transportation of GC through pipes. in order to prevent corrosion of these pipes. acid corrosion inhibitors (ACI). which are a wide variety of amines. are added to the product. which are characterized by a general structure:



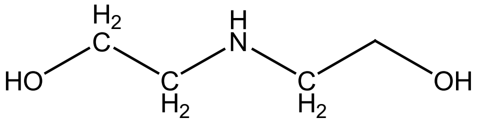
R – hydrocarbon radical with the number of carbon atoms from 5 to 20; n = 2–6; x and y are radicals for which n has different values from 1 to 10.

A large group of ACI with different R. n. x. y enters the market: Hercules. Sepakorr. Dodigen. etc. It is believed that the inhibitory effect of ACI is associated with ring rupture in the direction a–a. b–c. although other options are possible. As a result of this rupture. other non-cyclic or cyclic compounds are formed.

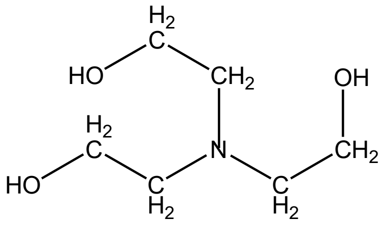
Thus. for the amine purification of GC from CO_2 and H_2S. GC containing a large number of ACI destruction products is supplied. Destruction continues when various amines are added to the volume of GC – monoethanolamine. diethanolamine and three ethanol amine:



monoethanolamine (1)

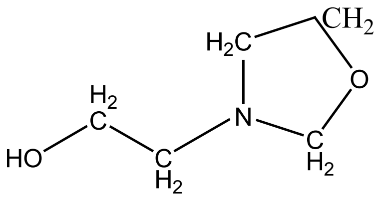


diethanolamine (2)

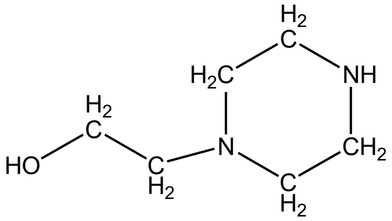


three ethanol amine (3)

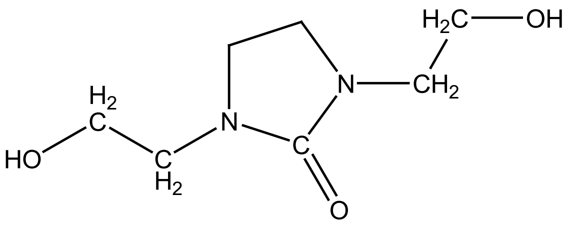
During the amine purification of GC from H_2S and CO_2. the interaction of DEA and TEA molecules with ACI occurs. both in the original state and in the form of their destruction products. In this case. polar substances are formed. among which those whose formulas are given below are found.



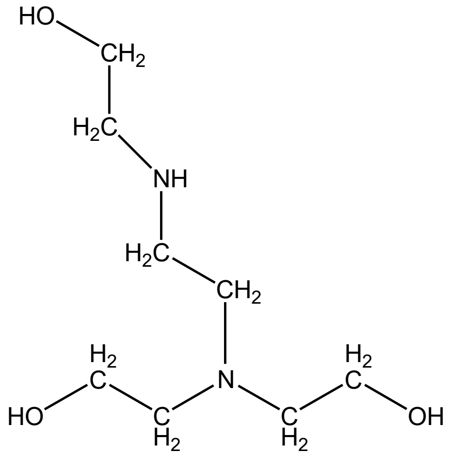
N-hydroxyethyl-a-azolizone (4)



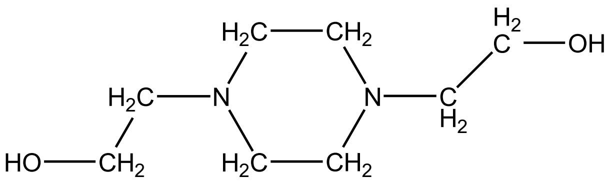
N – hydroxyethylpiperazine (5)



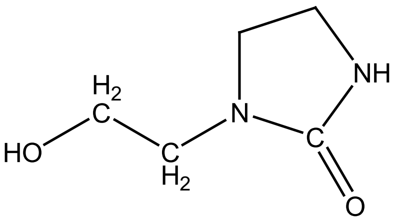
N.N-bis-oxyethylimidazoline (6)



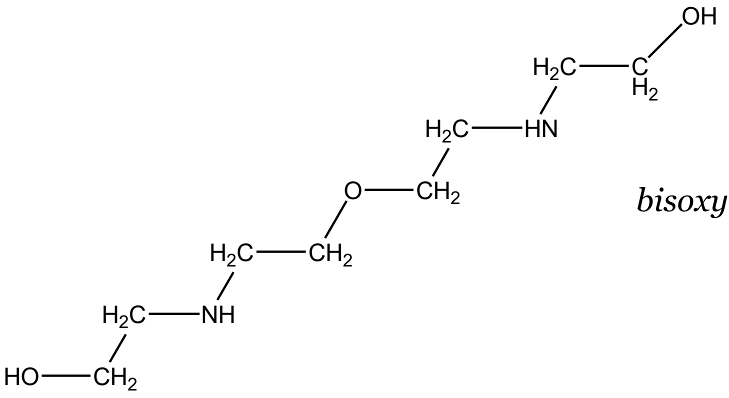
trihydroxyethylethylenediamine (7)



N.N-bis(2-oxyethyl)-piperazine (8)



N-hydroxyethylimidazolidone (9)



bisoxyethylaminoethyl ether (10)

Compounds (1). (4)–(8). (10) are classical nitrogen-containing cationic surfactants. highly soluble in water and involved in the formation of stable foam.

Compounds (5)–(10) also easily form ion pairs with H_2S or CO_2 and take part in liberating the environment from acid gases. but both in the free state and in the form of compounds with H2S or CO_2 they also form a stable foam.

Processes of nucleophilic and electrophilic substitution. electrophilic addition. intermolecular interactions. and condensation reactions are possible between alkanolamines.

their decomposition products. ACI and ACI decomposition products.

The purpose of this work was to assess the reactivity of compounds containing DEA. acid corrosion inhibitors (Dodigen. Hercules). as well as some fragments of ACI and compounds 5. 6. 8. 9. 10. Their reactivity was assessed using energy indices obtained using quantum chemical calculations.

Quantum chemical calculations were carried out in several software packages. The molecules were constructed in Chem Office-2004. and subsequent optimization and energy minimization. as well as refinement of geometric components and thermal characteristics. were carried out in Gamess (Rou Wang. Jianglong Yu. Faridul Islam. Arash Tahmasebi. Soonho Lee. Yixin Chen. 2020). The main calculation method is semi-empirical PM3 in the Hartree-Fock approximation. To solve the first problem. different states of each molecule were studied. taking into account their conformational diversity (Antoniou M.K.. Diamanti E.K.. Enotiadis A.. Policicchio A.. Dimos K.. Ciuchi F.. Maccallini E.. Gournis D.. Agostino R.G.. 2014; Caroline Thaler. Christian Millo. Magali Ader. Carine Chaduteau. François Guyot. et al.. 2017).

The data on steric energy was processed. so all calculations were carried out on stable structures that have low heats of formation. which determines the potential energy of a state in molecular mechanics.

Due to the fact that many of the molecules under consideration have a similar structure and identical reaction centers. all structures are divided into groups. This division makes it possible to more accurately trace the activity of a particular group.

in a molecule. The first group includes molecules (1). (2). (3). (7). (10). the second - (5). (9). the third - (4). (6). (8).

Comparative analysis of the reactivity of compounds (1–10). In table Table 1 shows the charge values in structures (1–10). Based on these data. it is possible to trace the distribution of charges throughout the molecule as a whole.

Table 1. *Distribution of charges in atoms of compounds (1–10)*

Connection 1		**Connection 2**	
–N–	–0.0279	–N–	–0.0536
–O–	–0.3080	–O–	–0.3098
–H*–	0.1830	–O*–	–0.3094
–H**–	0.0260	–H*–	0.818
–C*–	0.0638	–H**–	0.0585
		–C*–	0.0620
Connection 3		**Connection 4**	
–N–	–0.0935	–N–	–0.1185
–O–	–0.3071	–O–	–0.3115
–O*–	–0.3145	–O*–	–0.2788
–O**–	–0.3070	–H*–	0.1950
–H–*	0.1895	–C*–	0.0705
–H**–	0.1915	–C**–	0.0750
–C*–	0.0669		
Connection 5		**Connection 6**	
–N–	–0.0672	–N–	–0.0658
–O–	–0.3035	–O–	–0.3052

Connection 1		**Connection 2**	
$-N^{*}-$	−0.0570	$-N^{*}-$	−0.0640
$-H^{*}-$	0.0418	$-O^{*}-$	−0.3005
$-H^{**}-$	0.1795	$-O^{**}-$	−0.3620
$-C^{*}-$	0.0575	$-H^{*}-$	0.1875
		$-H^{**}-$	0.1852
		$-C^{*}-$	0.0385
		$-C^{**}-$	0.2517
Connection 7		**Connection 8**	
$-N-$	−0.0715	$-N-$	−0.0660
$-O-$	−0.3145	$-O-$	−0.3058
$-N^{*}-$	−0.0579	$-N^{*}-$	−0.0453
$-O^{*}-$	−0.3109	$-O^{*}-$	−0.3577
$-O^{**}-$	−0.3165	$-H^{*}-$	0.0910
$-H^{*}-$	0.1857	$-H^{**}-$	0.1856
$-H^{**}-$	0.1980	$-C^{*}-$	0.0599
$-H^{***}-$	0.0470	$-C^{**}-$	0.2335
$-C^{*}-$	0.0389		
$-C^{**}-$	0.0775		
Connection 9		**Connection 10**	
$-N-$	−0.0876	$-N-$	−0.0500
$-O-$	−0.3120	$-O-$	−0.3025
$-N^{**}-$	−0.0745	$-N^{*}-$	−0.0680
$-O^{*}-$	−0.3060	$-O-$	−0.2645
$-H^{*}-$	0.1820	$-O^{*}-$	−0.3120
$-H^{**}-$	0.1945	$-H^{*}-$	0.0635
$-C^{**}-$	0.0560	$-H^{**}-$	0.1950
		$-C^{*}-$	0.0665

The main reaction centers are considered to be –OH. $-NH_2$. –NH. > C = O groups. In order to simulate the possible behavior of a molecule in any medium (solvent). as well as to identify the main area of the contact surface. the energy characteristics of compounds (1) – (10) were calculated. as well as the areas of the contact surfaces. the values of which are given in Table 2.

Table 2. *Energy characteristics of compounds*

№	ΔG°. kJ/mol	ΔH°. kJ/mol	Area of test sphere A_1	Contact area surfaces A_2	Solvent volume	E_{steric}. kJ/mol
1	−104.40	−215.20	202.00	80.00	55.00	18.22
2	−201.38	−419.02	274.22	124.12	95.10	104.00

№	ΔG°. kJ/mol	ΔH°. kJ/mol	Area of test sphere A_1	Contact area surfaces A_2	Solvent volume	E_{steric}. kJ/mol
3	–300.00	–625.12	283.00	165.02	131.25	161.00
4	–64.75	–375.00	245.00	136.00	103.00	15.55
5	106.00	–217.00	267–55	152.47	121.00	66.36
6	–99.02	–581.32	311.45	183.00	145.36	64.25
7	–194.82	–624.33	351.45	211.22	175.00	111.33
8	–13.40	–380.00	248.00	138.36	104.24	45.00
9	20.76	–417.85	328.00	195.00	131.23	97.85
10	–183.40	–600.95	363.42	216.00	171.00	26.04

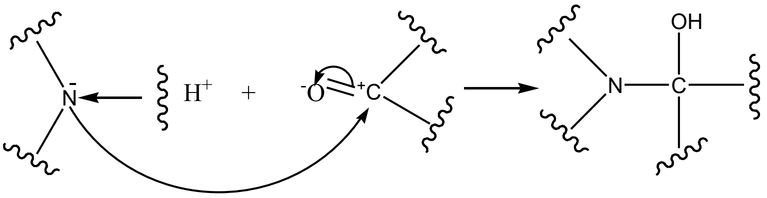
Legend: *ΔG°. kJ/mol – standard Gibbs energy. at T = 298 K; ΔH°. kJ/mol – standard heat of formation of a molecule from simple compounds at T = 298 K;* A_1 *is the area of the test sphere occupied by the solvent when rolling over the surface of the molecule under study;* A_2 *is the area of the contact surface that occurs during rolling research on the surface of the molecule under study;* A_3 *is the volume of solvent contained inside the contact surface; Esteric. kJ/mol – steric energy. used to describe the thermal motion of atoms of a molecular system (Coplen T. B., 2007)*

From the table 2 it can be seen that the contact surface area of N.N-bis-oxyethylimidazoline is higher than in the structure of N-oxyethylimidazolidone. This is primarily due to the presence of a linear branched carbon skeleton. with in this case. the volume of solvent contained inside the contact surface increases proportionally. A similar effect can be observed in the structures of the second group: thus. the N. N-bis-(2-oxyethyl)-piperazine molecule will be maximally involved in the solution. and to a lesser extent. N-hydroxyethylpiperazine.

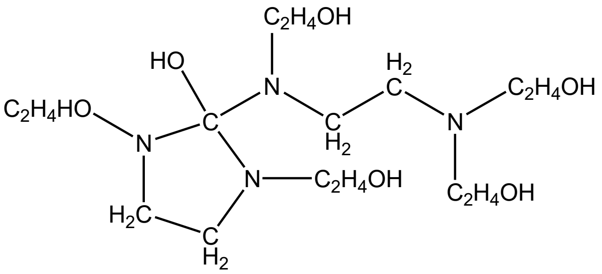
If we talk about the reactivity of N-hydroxyethylpiperazine. then it is necessary to note the weak influence of the imide group. and the largest contribution is made by the hydroxo group. through which electrophilic substitution can occur. as well as participation in the formation of hydrogen bonds. In the first group. structures (7) and (10) have the maximum contact surface area; this is also due to the branched carbon skeleton.

The maximum accumulation of negative charge on the nitrogen atom is observed in the three ethanol amine molecule (ρ = =–0.0933). which indicates the presence of a nucleophilic attack center. but steric hindrances associated with the location radicals in the molecule make it difficult to introduce other agents. so three ethanol amine occupies an intermediate position in this group in terms of its ability to interact.

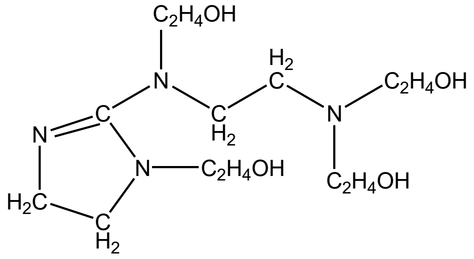
A similar state is characteristic of trioxyethylethylenediamine. but in this case the participation of the –NH group can make its own contribution to the nucleophilic attack. while the average value of the charges on the nitrogen atom is –0.065 and this is lower than for the three ethanol amine molecule. so one would expect a decrease in the reactivity of trioxyethylethylenediamine. But. having a branched linear structure. molecules (7) and (10) turn out to be the most active in this series. therefore they are able to react to form nitrogen-containing colored compounds:



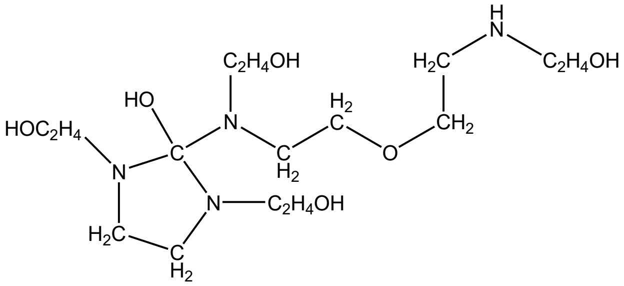
As a result of such interaction. the formation of the following compounds is possible:



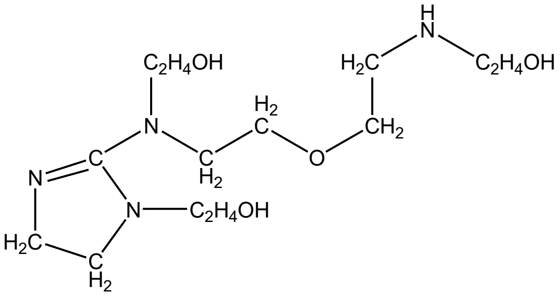
reaction product between (7) and (6) (11)



product of the reaction between (7) and (8) (12)

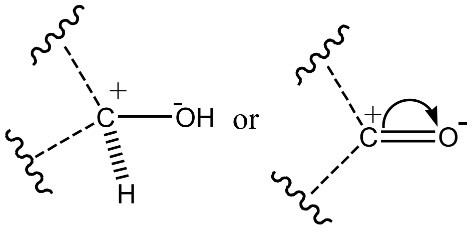


reaction product between (10) and (6) (13)



reaction product between (10) and (8) (14)

The maximum contribution to the reactivity is also made by the electrophilic centers of terminal carboxyl radicals and carbonyl groups. therefore. such compounds are characterized by nucleophilic substitution reactions:



The –NH group. which is capable of participating in addition reactions and the formation of nitrogen-containing colored products. has less activity; molecules (7) and (10) are prone to this effect; Identification of reaction centers made it possible to find out how all molecules will behave in a common active liquid-vapor environment: in relation to each other; in relation to gases entering (or released) into the system.

Calculations show that most of the individual substances considered can be the cause of intense foaming. One of the reasons may be the formation of compounds of the studied substances with hydrogen sulfide and other acid gases.

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INVESTIGATION OF THE CHIMERIC COMPOSITION OF IMPORTED ENERGY DRINKS

Radjabova Lobar Ramazanovna[1]

[1] Institute of Natural Resources Management NIU "TIIIMSH". Bukhara

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Abstract

The article analyzes the labeling of energy drinks in accordance with the requirements of regulatory and technical documentation. The norms of content of recipe components providing optimal tonic effect, availability of information on the package about temperature conditions and shelf life, about recommendations for consumption and daily consumption rate are studied.

Keywords: *Energy drinks, tonic drinks, classification, safety, use, normative and technical ocumentation, producers, consumers*

Introduction

Currently, there is a certain "fashion" for the use of energy drinks (EN), the turnover of which occupies a significant part of the Russian market The main consumers of EN are young people who use them as drinks for rest, relaxation, and performance enhancement. Despite the growing growth of EN production, it hould be noted that the legislative framework and the level of control over their quality and safety are imperfect, which may serve as a risk factor for the emergence of relevant diseases There is currently no unified classification and definition of EN.

Domestic producers of EN produce this type of products according to GOST 28188–89 "Non-alcoholic beverages.

General technical conditions". This standard applied to liquid soft drinks and to finished concentrates of soft drinks to be realized in retail trade network. A. V. Oreschenko and A. D. Durnev proposed to refer EN to the subgroup of products of adaptogenic action, i.e. to drinks that ensure the functioning of the body in conditions of increased intellectual and physical stress. Specialists of Quesf UTS identify them as functional drinks based on vegetable raw materials. According to other foreign sources, EN is an independent group of functional drinks. In 2007 national standards GOST R52844–2007 "Non-alcoholic tonic drinks" and GOST R52845–2007 "Low-alcoholic tonic drinks" were approved and put into effect. These normative documents define non-alcoholic and low-alcoholic EN, non-alcoholic and low-alcoholic tonic drinks, which allowed to classify EN by appearance, degree of saturation with carbon dioxide, as well as depending on the method of processing. Non-alcoholic energy drinks – non-alcoholic tonic drinks with a mass fraction of dry substances not less than

10%; non-alcoholic tonic drinks – non-alcoholic drinks of special purpose containing caffeine and/or other tonic components in an amount sufficient to provide a tonic effect on the human body. Low-alcoholic energy drinks – low-alcoholic tonic drinks with a mass fraction of sugar not less than 10%; low-alcoholic tonic drinks – special purpose drinks containing caffeine and/or other tonic components in an amount sufficient to provide a tonic effect on the human body.

The above GOSTs provide a classification of non-alcoholic and low-alcoholic tonic drinks, which also applies to energy drinks. Non-alcoholic and low-alcoholic EN by appearance are subdivided into types: – transparent; – turbid.

Non-alcoholic and low-alcoholic EN by the degree of saturation with carbon dioxide are subdivided into types: – non-carbonated; – carbonated.

Non-alcoholic and low-alcoholic ENs are subdivided depending on the method of processing:

- to unpasteurized;
- pasteurized;
- beverages with preservatives;
- preservative-free beverages;
- cold bottled beverages; – hot bottled beverages; – aseptic bottled beverages.

According to GOST R52844–2007 by physical and chemical parameters non-alcoholic EN should meet the requirements specified in Table 1.

The recommended levels of content of some components in non-alcoholic EN, providing optimal tonic effect, are presented in Table 1.

Table 1.

Component	Content, mg/cm³ beverage
Caffeine	25–35
Substrates and stimulators of energy metabolism:	
taurine	300–400
L- carnitine	80–120
glucuronolactone	150–240
Vitamins and vitamin-like substances:	
vitamin B_3	6–8
vitamin B_5	1–2
vitamin B_6	1–2
vitamin B_{12}	0.001–0.002
inositol	10–25

The recommended levels of content of some substrates and stimulants of energy metabolism in low-alcohol EN according to GOST R52845–2007 are presented in Table 2.

Table 2. *Recommended levels of some substrates and stimulants of energy metabolism in low-alcohol ENs*

Component	Content, mg/cm³ beverage
Taurine	300–400
L-carnitine	80–120
Glucuronolactone	150–240

Objects and methods of research

In the present work, studies have been carried out to examine the labeling of ENs for compliance with the requirements of the above standards.

The objects of the study are selected EN sold in Kemerovo. The assortment and manufacturers of products are presented in Table 3.

Table 3. *The range of EN sold on the Kemerovo market*

Research object (trade name)	Manufacturer
EN group: non-alcoholic	
Red Bull, Bullit	Red Bull GmbH, Fuschl am See, Austria
Pitbull	Poland, Koszalin 75–211
Burn	Coca-Cola HBC Eurasia LLC, Novoaleksandrovka village. Azov district, Rostov region.
Flash	“Baltika-Pikra, Krasnoyarsk
Adrenaline Rush, Adrenaline Nature	Megapack Domodedovo Branch, Domodedovo, Moscow Region
MD Guarana, XXI power Guarana	ART Modern Scientific Technologies LLC, Golikovo Solnechnogorsk District, Moscow Region
Tornado, Tornado ice	Production Company LLC “Leader”, Malakhovka village, Lyubertsy district, Moscow region
Spring Energy	Individual Entrepreneur Tsirikhidze O. O., Omsk
Super Max	Aqua-Vita LLC, Yurga, Kemerovo region.
EN group: low-alcohol	
Strike sky, Strike dark, Scorpion	LLC “Distillery “OSHA”, Rakitinka village Omsk District, Omsk Region
Super JaguarOriqinal Light, Jaguar Gold, Black Russian	United Bottling Group LLC, Tver
Jaguar Aktive, Red Devil	Megapack LLC, Vidnoye Leninsky District, Moscow Region

It follows from the data of Table 3 that the widest range of products is represented by OOO United Bottling Group (Tver) and OOO Osha Distillery (v. Rakitinka, Omsk district, Omsk region). An individual entrepreneur (Spring Energy drink) was registered among Russian manufacturers. The well-known international trademarks Red Bull and Bullit are represented on the market of the Russian Federation by the Austrian company Red Bull GmbH.

The inscription is a mandatory requirement of the technical documentation for the EN:

– for non-alcoholic EN: “Not recommended for persons under 18 years of age, elderly and elderly, hypertensive patients, with cardiac disorders, increased nervous excitability, severe atherosclerosis, insomniacs, pregnant and lactating women”;

– for low-alcohol EN: “Not recommended for persons under 18 years of age, older and elderly people suffering from insomnia, pregnant and lactating women, patients with hypertension, cardiac disorders, increased nervous excitability, diseases of the central nervous system, kidneys, liver and other digestive organs”.

The range of prevention of non-recommended use of low-alcohol EN is much broader than that of non-alcoholic EN.

This can be explained by the fact that ENs are stimulants, alcohol in this case is an axiolytic. It is likely that their combination may be unsafe for health. Stimulant effects mask the degree of intoxication and prevent adequate perception of the amount of alcohol consumed (Paken P., 2010).

The next important condition for product labeling is the availability of information on the quantitative content of tonic components and recommendations for limiting daily consumption (in packaging units) in accordance with the content of biologically active substances and the values of upper permissible levels of daily consumption.

The technical documentation provides recommended levels of content of some components that provide an optimal tonic effect. As tonic ingredients it is allowed to use caffeine and/or plant extracts (guarana, mate, ginseng, lemongrass, eleutherococcus), minerals, vitamins and vitamin-like substances, substrates and stimulators of energy metabolism (GOST

R52844-2007. 2008; GOST R52845-2007. 2008). In the production of non-alcoholic EN, easily digestible carbohydrates are also introduced into the formulation.

The conducted marketing research showed that young people pay attention primarily to the content of caffeine and other tonic substances. Therefore, the next step of the research was to study the content norms of some components that provide optimal tonic effect, substrates and stimulators of energy metabolism of EN, as well as the presence of information on the packages about temperature conditions and shelf life, undesirable consumption and daily norm (Tables 4 and 5).

Table 4. *Content of tonic substances in non-alcoholic ENs*

Recommended level Non-alcoholic EN	**Ingredients. mg/100 cm^3**								
	caffeine	**taurine**	**L–Carnitine**	**Glucuronolactone**	**Vitamin B$_3$**	**Vitamin B$_5$**	**Vitamin B$_6$**	**Inositol**	**vitamin B12**
	25–35	**300–400**	**80–120**	**150–240**	**6–8**	**1–2**	**1–2**	**0.010–0.025**	**0.001–0.002**
Red Bull	30	340	–	240	8	2	1.7	+	0.002
Bullit	30	240	–	–	7.2	2	0.8	–	0.0004
Burn	No more than 350	+	–	+	5.8	1.1	0.6	At least 0.010	0.00028
Flash	27	120	–	–	6.0	1.5	0.6	–	–
Adrenaline Rush	No more than 30	399	100	–	–	–	0.8	0.0217	0.0004
Adrenaline Nature	No more than 30	–	–	–	–	–	–	–	–
MD Guarana	40	+	–	–	+	–	–	–	+
XXI power guarana.	20	–	–	–	–	+	0.9	–	–
Tornado	No more than 15	17	–	–	3.4	1.4	0.3	–	–
Tornado ice	No more than 14	No more than 120	–	–	–	–	–	–	–
Spring Energy	No more than 30	–	–	–	6.0	2.4	0.6	–	–
SUPER MAX	30	+	–	+	+	+	+	–	+

Note: "+" indicates the presence of the ingredient in the beverage; "–" indicates the absence of the ingredient in the beverage

Table 5. *Content of some substances in low-alcohol Ens*

Advisable level Low-alcohol EN	**Ingredients**					
	caffeine, mg/100 cm^3	**taurine, mg/100 cm^3**	**L–Carnitine, mg/100 cm^3**	**Glucuronolactone, mg/100 cm^3**	**Volume fraction of ethyl alcohol,%**	**Mass Fraction sugars,%**
	0.151–0.400	**30–400**	**80–120**	**150–240**	**1.2–9.0**	**At least 10**
Strike Sky	30	240	–	–	8.0	11.5
Strike Dark	30	240	–	–	8.0	11.5

Advisable level Low-alcohol EN	**Ingredients**					
	caffeine, mg/100 cm^3	**taurine, mg/100 cm^3**	**L–Carnitine, mg/100 cm^3**	**Glucuronolactone, mg/100 cm^3**	**Volume fraction of ethyl alcohol,%**	**Mass Fraction sugars,%**
	0.151–0.400	**30–400**	**80–120**	**150–240**	**1.2–9.0**	**At least 10**
Jaguar Light	30	–	–	–	5.5	11.5
Jaguar Active	30	40	–	–	7.0	11.5
Jaguar Gold	30	30	–	–	7.0	11.4
Red Devil	30	30	–	–	9.0	11.0
Черный русский	30	–	–	–	7.0	8.5
Scorpion	30	30	–	–	8.0	12.1

Note: "–" represents the absence of an ingredient in a beverage

Results and their discussion

There was a certain difficulty in studying the annotation in Russian, which indicates the labeling of Pitbull EN, as all the information on the package is in English and there is no violation of the law "On Protection of Consumer Rights" (Federal Law No. 2300-1 of February 7, 1992) and non-compliance with the requirements of GOST R51074-2003 "Food Products". (Federal Law No. 2300–1 of February 7, 1992) and non-compliance with the requirements of GOST R51074-2003 "Food products. Information for the consumer" (GOST R51074-2003. 2005). In this case it is impossible to identify Pitbull EN.

The information presented in the tables shows that low-alcoholic EN and non-alcoholic EN are produced in accordance with the requirements of GOST R52845-2007 and GOST R52844-2007 standards respectively (exceptions are the drinks produced according to TU9185-020-40227765 – Burn, TU9185-001-17998155 – Adrenaline Rush, TU9197-12818934223-07 – MD Guarana, TU9185-090-1893422304 – XXI power Guarana).

The results of the conducted research show that information for persons who are not recommended to consume EN is absent on the packages of MD Guarana and XXI power Guarana. Information on the recommended daily consumption rate is not indicated on the labeling of the following ENs: XXI power Guarana, Tornado, Tornado ice and Spring Energy. There is no information about temperature conditions and shelf life on the package of MD Guarana EN. Further we studied the quantitative content of caffeine, which in EN Tornado, Tornado ice, Spring Energy was below the minimum threshold, stated in the standard recommended level, by 10–11 mg per 100 cm^3, in the drink Burn, on the contrary, exceeds 10 times the maximum threshold.

The information from the packaging of Red Bull EN is of interest. In the trade network this EN is sold in different volumes: 0.250, 0.355 and 0.473 cm^3. When labeling the manufacturer indicates the content of caffeine – 0.03% in 100 cm^3, which is 30 mg per 100 cm^3 regardless of the package volume, thus guaranteeing the norm of this tonic substance and the same effect from the consumption of 0.250, 0.355, and 0.473 cm EN. 3

Taurine is present in Tornado EN, Tornado ice. Its content is below the minimum recommended level.

The inscription on the label indicates that these drinks are energy drinks. At the same time, the content of tonic substances does not meet the standards given in GOST: caffeine – 25–35 mg/100 cm^3, taurine – 300––400 mg/100 cm^3.

In this regard, it is recommended that enterprises producing EN include no more than two tonic components in the composition of non-alcoholic EN, and no more than one tonic component in the composition of low-alcoholic EN (. Federal Law No. 102-FZ of July 19, 2005).

Adrenaline Rush drink contains three tonic ingredients: caffeine, guarana extract and ginseng extract.

In addition to natural caffeine, Adrenaline Nature EN contains Siberian ginseng extract, concentrated orange extract, natural flavoring "Guarana extract". Their quantitative content is not specified. It should be noted that the above composition duplicates other information on the package: "Adrenaline Nature is produced using natural tonic ingredients: natural caffeine from coffee beans, guarana extract from the banks of the Amazon River".

Consequently, the manufacture of Adrenaline Rush and Adrenaline Nature ENs is in violation and does not comply with the recommendations reflected in the regulation "On strengthening the supervision of beverages containing tonic ingredients" from 19.01.2005 г. № 2 (Federal Law No. 102-FZ of July 19, 2005). The study of vitamin composition labeling showed that no vitamins are used in the manufacture of Tornado ice EN. MD Guarana and Super Max packages do not contain the quantitative content of vitamins.

The study of labeling on consumer packaging has served as a basis to conclude that not all manufacturers in the production of EN using tonic ingredients are guided by the standards of GOST R52844-2007 and GOST R52845-2007.

In addition, the packaging of some beverages contains information that may mislead the consumer. For example, the package of Red Bull EN contains the following inscription: "Increases efficiency, concentration and reaction speed, alertness. Raises mood. Improves metabolism. This information can be considered as advertising, not confirmed by the prescription composition and expert opinion of the Ministry of Health of the Russian Federation.

On the package of MD Guarana EN the type and number of documentation (TU9197-128-18934223-07), according to which the production is carried out, are indicated. Analyzing the class, subclass and group of products (the first four digits of the number of technical specifications), we can conclude that this drink according to the AllRussian classifier should belong to the class – products of food industry, subclass – products of tea, salt, tobacco and tobacco powder industry and production of food concentrates, group – dry products for baby food, dietary and therapeutic and preventive nutrition and wastes of their production.

Some labels (e.g. EN XXI power Guarana) have spelling errors, which also undermine the image and reputation of EN companies.

According to E. S. Severin, E. Coleman, R. Murray, D. Grenner, etc., taurine and caffeine have multidirectional effects, which causes imbalance of human cellular systems. And such popular components of EN as taurine and glucuronolactone are synthesized in the human body in sufficient quantity and do not require additional administration. L-carnitine transports long carbon radical fatty acids across the mitochondrial membrane. ENs do not contain fatty acids in their formulation, so there is no need to use L-carnitine. Thus, the combination of the above-mentioned biologically active substances as components providing optimal tonic effect in the composition of EN is irrational.

The results of the conducted research allow us to make the following recommendations.

1 Update GOST R52844–2007 "Non-alcoholic tonic drinks. General technical conditions" and GOST R52845–2007 "Low-alcohol tonic drinks. General technical conditions":

- use caffeine, vitamins and vitamin-like substances as components that provide a tonic effect;
- exclude taurine and glucuronolactone from the composition of EN, as these substances are synthesized in the human body in sufficient quantities;
- consider the use of Lcarnitine inappropriate, as this component does not have a tonic effect;
- take the volume of the packaging unit as 200 cm^3.

2. In GOST R52844–2007 exclude Table A.1 of the Annex "Recommended levels of content of some components in non-alcoholic tonic drinks that provide optimal tonic effect". To introduce "Mandatory requirements for the content of some components in non-alcoholic tonic drinks", which are safe for life and health of consumers (Table 6) (Poznyakovsky, V. M., 2009).

Table 6. *Mandatory requirements for the content of certain components in non-alcoholic tonic drinks*

Component	Content, mg/100 cm^3 of beverage	Daily Value Consumption, mg
Caffeine	150*	300
Vitamins and vitamin-like substances:		
Niacin (vitamin PP)	1–60*	15–20
pantothenic acid (vitamin B_5)	Not regulated	0.25–5.0
pyridoxine (vitamin B_6)	0.1–6.0*	2–3
cyanocobalamin (vitamin B_{12})	0.00015–0.009*	0.003
Inositol	25–1500*	500–1000

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Contact: uzbekiston@inbox.ru

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DETERMINATION OF Z-HYDROGEN N. N-DIETHYLDITHIOCARBAMATE SODIUM AND NON-HYDROGEN SOLUTION

Yakhshieva Zuhra Ziyatovna [1], ***Kalonov Rustam Mamadiyorovich*** [1]

[1] Department Chemistry and methods of teaching it Jizzakh
State Pedagogical University, Uzbekistan

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Abstract

The article presents the results obtained in determining the dielectric constant, electrical conductivity and viscosity of solutions containing Sb(III) and Bi(III) ions, individual solvents and their mixtures containing indifferent salts of different nature: potassium acetate, sodium, lithium nitrate and perchlorate and sodium, used as background electrolytes in determining microconcentrations of the studied ions, optimizing the conditions for determining Sb(III) and Bi(III) ions with various reagents.

Keywords: *dielectric constant, electrical conductivity, viscosity, antimony, bismuth, voltammetry*

Introduction

The content of microelements in waters and industrial waste products usually does not exceed 0.00001%, therefore, their reliable determination requires the use of highly sensitive analytical methods, and therefore instrumental methods of analysis. The choice of an instrumental method of analysis for the determination of microelements in waters and industrial waste products is determined by a number of the following characteristics of the method: the required sensitivity and accuracy of the method, the number of elements to be determined and objects of analysis, the availability of certified and sponsored analysis methods, ease of analysis, and the cost of the analyzer (Yakhshieva, M. Sh., 2015; Yakhshieva Z.Z., Kalonov R.M., 2020).

Voltammetric methods of analysis are based on deciphering polarization curves – voltammograms obtained in an electrochemical cell filled with a solution of the analyzed sample. A new impetus for the widespread use of voltammetry was given by the need to control the content of toxic microelements in food products.

The high sensitivity of the method is achieved by the preliminary electrochemical concentration of the analyte on the surface of the indicator electrode.

He analytical signal is the maximum dissolution current of the concentrate of the element being determined, recorded on the voltammogram in the form of a peak or several peaks if several elements are concentrated and determined simultaneously. The position of the peak on the potential axis characterizes the nature of the component being determined, and the height or area is proportional to its concentration in solution under constant conditions of electron accumulation.

Since by selecting appropriate conditions (solvent, electrode material, reagents, etc.) a wide variety of substances can be converted into an electroactive state, methods have now been developed for the voltammetric determination of Sb(III) and Bi(III) ions in the concentration range from 10–3 to 10–11 M.

The advantages of a modern voltammetric analyzer (polarograph) are relative ease of operation, low cost; high sensitivity; sufficient selectivity and rapidity of determination; the ability to automate the process of measuring the analytical signal (Gevorgyan, A. M. Ziyaev, D. A. Kireeva, G. V., 2010; Ziyaev D. A., 2021; Shaidarova L. G., Chelnokova I. A., Gafiatova I. A., Gedmina A. V., Budnikov G. K., 2022; Aronbaev S. D., Aronbaev D. M., Narmaeva G. Z., 2018).

During the experiments, the dishes were pre-soaked for a day in deionized water. After this, rinse 2–3 times.

Solutions were prepared in double-distilled water using twice-recrystallized thiocarbamide $(NH_2)_2CS$ ("pure for analysis"), disodium salt of ethylenediaminetetraacetic acid Na2H2 EDTA in the form of a standard titer, and recrystallized $NaNO_3$. A solution of bismuth (III) perchlorate was prepared by dissolving a weighed portion of bismuth (III) oxide ("reagent grade") in perchloric acid ("reagent grade"). Measurements of the acidity of electrolytes were carried out at a temperature of 20±0.1 °C on a pH-150M device with an ES-10601/7 glass electrode.

Anodic dissolution and cathodic reduction of bismuth ionization products were studied in solutions: 1) containing only the disodium salt of ethylenediaminetetraacetic acid (Na_2H_2 EDTA); 2) in the combined presence of Na_2H_2 EDTA and thiocarbamide (Thio) of various concentrations; 3) in the combined presence of Na_2H_2 EDTA and thiocarbamide (Thio) of varying concentrations and a constant concentration of bismuth (III) chlorate. All studies were carried out at pH 6.0. The choice of medium acidity is not random. As an analysis of literature data shows, at pH < 7, complexes with dissimilar ligands of the composition (Bi EDTAThio)– (Yakhshieva Z. Z., Kalonov R. M., 2020; Bakahonov A. A. Yakhshieva Z.Z, Kalonov R. M., 2020) are formed in the bulk solution.

Antimony solutions were prepared in bidistilled water using the following reagents: Sb_2O_3 (reagent grade); $HClO_4$ ("reagent grade"); sodium thiosulfate $Na_2S_2O_3$ (analytical grade), disodium salt of ethylenediaminetetraacetic acid Na_2H_2 EDTA in the form of standard titer, recrystallized $NaNO_3$ (analytical grade). The study was carried out against a background of 0.5 M $NaNO_3$ at pH 6.0. Measurements of the acidity of electrolytes were carried out with an accuracy of ±0.05 pH units on a pH-150M device with an ES-10601/7 glass electrode, previously calibrated using standard buffer solutions. The acidity of the solutions was adjusted to the required value using solutions of HNO_3 and NaOH (reagent grade).

When determining antimony and bismuth ions, we used a voltammetric analyzer TA-Lab, which is designed for highly sensitive measurements of the content of As, Cd, Pb, Cu, Zn, Mn, Hg, Se, I, Ni, Co, Fe, Ag, **Sb, Bi**, Fe ions, Sn in drinking, natural, wastewaters, aqueous solutions of soil samples, food products, industrial concentrates.

To successfully carry out the complexometric titration of Sb(III) and Bi(III) ions in non-aqueous media, we chose a solution of sodium N, N-diethyldithiocarbamate, which is a water-soluble salt of the organosulfur composition of pale yellow color with the formula $C_5H_{10}NS_2Na*3H_2O$ (Yakhshieva Z. Z., Kalonov R. M., Abdurahmonov B., 20200).

Since there are no quantitative data in the literature on the solubility of $C_5H_{10}NS_2Na*3H_2O$ and its salts in various organic solvents, it was necessary to determine the solubility of $C_5H_{10}NS_2Na*3H_2O$ in CH_3COOH, C_2H_5OH, dimethylformamide (DMFA), CF_3COOH, CH3CN, $CH_3CH(OH)CH_3$, HO-CH2CH2-NH2 and with their mixtures $CHCl_3$, C_6H_6, CCL_4, C6H14, CH_3-CO-CH_2-CH_3, HO – CH2–CH2–OH, CH3–C(O)–CH3 and C4H8O2.

Experiments have shown that the highest solubility of $C_5H_{10}NS_2Na*3H_2O$ and its salts without the addition of indifferent electrolytes is observed in DMFA, CF_3COOH, and in a mixture of HO-CH2CH2-NH2 and HO-CH2-CH2-OH. It has been established that under the influence of additives of inert solvents, the solubility of the organic reagent $C_5H_{10}NS_2Na*3H_2O$ decreases significantly.

Thus, when preparing standard solutions of $C_5H_{10}NS_2Na*3H_2O$ and its salts, the following systems can be used as organic solvents:

$CH_3COOH \leftrightarrow$ HO-CH2CH2-NH2;

$CH_3COOH \leftrightarrow CF_3COOH$;

$CH_3COOH \leftrightarrow$ HO – CH2–CH2–OH.

However, the solubility of the titrants used in protolytic media and their mixtures with other solvents is not high enough (10^{-3} M) and therefore it is necessary to find a way to prepare at least $5 \cdot 10^{-3}$ M $C_5H_{10}NS_2Na*3H_2O$ and its salts in anhydrous acetic acid.

To solve this problem, we took advantage of the well-known fact that the solubility of many electrolytes both in water and in organic solvents increases under the influence of the high ionic strength of the solution, caused by the presence of foreign indifferent salts in it (Lebedeva M. I., Isaeva B. I., Borisova R. V., 2012). In the protolytic solvents used, this effect is much stronger than in the case of water (Denesh I., 2003). The solubility of the titrant in organic solvents also strongly depends on the dielectric constant of the solvent itself (Ahadov Ya. Yu., 2007) and is expressed by the equation:

$$lgS_m = const + \left(\beta_\mu^1 - \beta\right) \cdot \frac{1}{D_M} \qquad (1)$$

where S_m – solubility in non-aqueous solvent (mol/m^3); β_μ^1, β – permanent (F · mol/m^2); D_M – solvent dielectric constant (F · m.); – dipole moment (Kl.m.).

From this we can conclude that the solubility of ions of the metals and complexants under study is a linear function of the solvent. Magnitude $\beta_\mu^1 - \beta$, as rule, has a negative value and solubility decreases with decreasing dielectric constant.

The solubility of a substance also depends on the ratio of the polarities of the solute and solvent. It will be maximum when the ratio of both components – solute and solvent is close to unity:

$$\frac{\mu_{1\,об}}{\mu_{2\,об}} \approx 1, \; where \; \mu_{об} = \frac{M}{V} \qquad (2)$$

where V – is the volume of the molecule

The solubility of $C_5H_{10}NS_2Na*3H_2O$ increases with increasing concentration of background electrolytes. It was experimentally found that when the content of potassium acetate (1.5–1.6 M) the solubility of $C_5H_{10}NS_2Na*3H_2O$ in anhydrous acetic acid increases so much that even 0.01–0.02 M solutions of this reagent can be easily prepared. Under the influence of lithium perchlorate, its solubility increases, but in this case, at a 1.5 M content of this salt, a 0.01 M solution of $C_5H_{10}NS_2Na*3H_2O$ can be prepared.

Thus, using the above-mentioned indifferent salts to effectively increase the solubility of $C_5H_{10}NS_2Na*3H_2O$ and its salts, it is possible to obtain standard 0.004–0.02 M solutions of reagents, with which, provided that a 2–
–5 ml piston microburette is used, it is possible to titrate 0.10–10, 0 μg/ml of the studied ions Sb(III) and Bi(III) quantitatively reacting with $C_5H_{10}NS_2Na*3H_2O$ in non-aqueous media. To optimize the conditions for determining Sb(III) and Bi(III) ions with various reagents, it is necessary to determine their dielectric constant, viscosity, and electrical conductivity of titrated non-aqueous solutions.

Literary (Kreshkov A. P., 2009; Kreshkov A. P., Yarovenko A. N., Bartikova O. D., 2003) and our data confirmed that among alkali metal salts, lithium salts (due to the small radius of the cation) are the most strongly solvated compounds compared to sodium and potassium salts.

It could be expected that the addition of an inert solvent (chloroform, benzene, carbon tetrachloride, hexane, methyl ethyl ketone, etc.) with an even lower dielectric constant than that of the protolytic solvent: acetic acid, n-propanol, DMFA, would increase the degree of titration. On the other hand, a significant increase in the ohmic resistance of the solution under study causes a significant drop in its potential in it, which will inevitably entail a rapid violation of the proportionality between the magnitude of the current and the concentration of the complexant in the analyzed solution. Thus, there must be some optimal and maximum permissible concentrations of the inert solvent in acetic acid, as well as in n-propanol, DMFA, at which correct and reproducible titration results should be ensured.

Experimental data was obtained in determining the specific electrical conductivity and viscosity of titrated solutions, individual solvents, and their mixtures containing indifferent salts of different nature: potassium acetate, sodium acetate, lithium, and sodium nitrate, and perchlorate, which were used as background electrolytes when determining micro concentrations of the studied ions, confirmed our assumptions.

A study of the effect of chloroform on the viscosity of acetic acid solutions containing potassium acetate, lithium nitrate, and perchlorate showed that the greatest decrease in viscosity is observed in solutions containing potassium acetate, and the smallest in lithium nitrate.

Experiments have shown that chloroform greatly reduces the viscosity of propanol, acetic acid, and dimethyl sulfoxide solutions (background – potassium acetate) and increases the viscosity of dimethylformamide solutions.

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Contact: yaxshiyeva67@mail.ru

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Section 2. Food procceding industry

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THE INFLUENCE OF THE MAIN TECHNOLOGICAL PARAMETERS OF COLD PRESSING OF LOCAL VARIETIES OF SUNFLOWER SEEDS ON THE YIELD AND QUALITY OF OIL

Gafurov K. Kh. [1]***, Safarova D.N.*** [1]

Bukhara Engineering-Technological Institute, Uzbekistan

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Abstract

The scientific research studied the influence of the main technological parameters (rotation speed of the screw shaft and the thickness of the press outlet slot) during cold pressing on the yield and quality of oil from local varieties of sunflower seeds. Using Response surface methodology, it was revealed that, at a shaft rotation speed of 35 rpm and a slot thickness of the outlet opening of 7.5 mm, the residual oil content of the cake will be in the range of 10–10.5%; and the acid number of the resulting oil is in the range of 1.65–1.7 mg KOH.

Keywords: *sunflower seeds, oil, pressing, shaft rotation speed, outlet slot thickness, oil yield, acid number*

Introduction

In the world practice of producing vegetable oils in general, and sunflower oil in particular, there are two fundamentally different ways of extracting oil from seeds: pressing, i.e., mechanically squeezing oil from seeds suitably prepared for pressing; extraction of oil with a highly volatile organic solvent (extraction method). These two main methods are used in the technology of production of vegetable oils either independently or in a certain combination of one with the other, which is determined, as a rule, by the type and quality of the initial processed oilseed raw materials (Shcherbakov V.G., 1992). With the pressing method, the depth of oil removal is limited with the current state of technology. As a result, the oil content of the cake fluctuates on average between 8.0–15.0%. With the extraction method, the depth of oil extraction increases, the oil content of the resulting meal is on average about 1.0% (Shcherbakov V.G., 1992; O'Brien R., 2007).

Increasing the depth of oil extraction by the pressing method requires the use of higher temperatures and pressure during extraction, which, in turn, causes an increase in the specific metal consumption of pressing units, an increase in the specific consumption of electricity, labor and production costs for restoration and repair work (Zaitseva L.V. and Nechaev A.P., 2019; Gupta M., 2017; Dijkstra A., Duijn G., 2016). The use of higher temperatures (110–120 °C) leads to a decrease in the quality of extracted oils due to an increase in their content of oxidation products, free fatty acids, coloring matter, etc. (Zaitseva L.V. and Nechaev A.P., 2019; Gupta M., 2017; Dijkstra A., Duijn G., 2016).

The most effective, in terms of maintaining the quality characteristics of vegetable oil, is cold pressing at low temperatures (Proctor A., 2013; Gafurov K. Kh., 2020). This method is the most "natural" way to produce vegetable oils. At the same time, the oil does not heat up much (no more than 40 °C), which ensures the preservation of all nutritional and beneficial components. It contains the entire range of nutrients and beneficial substances (microelements, macroelements and vitamins) that are necessary in the human diet. This happens because at this processing temperature, many healing substances and vitamins inherent in this product are preserved (Proctor A., 2013; O'Brien R., 2007; Gafurov K. Kh., Safarova D.N., 2022).

The work (Mustafaev S.K., Kalienko E.A., Sonina D.V. and Efimenko S.G., 2014) noted that the term "cold pressing" does not have clear boundaries in terms of process temperature. The temperature at which pressing is considered cold in the EU is 27–30 °C, while in the USA a pressing temperature in the range of 60–99 °C is still considered cold pressing. There are other temperature ranges for cold pressing in the literature. According to (Mustafaev S.K., Kalienko E.A., Sonina D.V. and Efimenko S.G., 2014), the optimal temperature on the press should not exceed 60 °C.

The work (Çakaloğlu B., Özyurt V.H. and Ötleş S., 2018) provides a review analysis of the cold pressing method, where traditional extraction methods are assessed in terms of advantages, disadvantages of technology and operating principles equipment, which states that cold-pressed oils are generally suitable for direct consumption and do not require refining, and to optimize oil recovery, the product must be pre-treated with heat until the material reaches a moisture content of no more than 10%. Cold pressing has been shown to be preferred over other methods of oil extraction (for example, extraction) due to its ease of use, low cost, environmental friendliness, and absence of harmful organic substances.

But with the cold production method, up to 30–40% of the oil present in the seeds is extracted. To completely extract it, it is necessary to thoroughly destroy the cellular structure of the oil-containing raw material (Shcherbakov V.G., 1992). To achieve this, many researchers have proposed various electrophysical effects on oil-containing raw materials. This is a short-term exposure to electromagnetic microwave waves, infrared radiation and other influences (Ilyasov S.G., Krasnikov V.V., 1978; Krajewska M., Ślaska-Grzywna B. and Andrejko D., 2018; Cai Z., Li, K., Lee W.J., Reaney M., Zhang N. Wang Y., 2021).

The purpose of this work is to study the technological modes of pressing sunflower seeds subjected to preliminary infrared (IR) heat treatment, followed by a study of the indicators of the resulting oil and cake.

Object and methods of research

The object of study was the Dushko sunflower hydride, included in the State Register of Agricultural Crops Recommended for Sowing in the Republic of Uzbekistan. Before pressing, the sunflower seed mince was treated with infrared rays with a heat flux density of 7.2 kW/m ^{2} and an irradiation duration of 60 s in the mode: +60–120+35–120+35–−120+35–120+30 (sign "+ " «indicates the duration of IR irradiation; the sign «–» indicates the duration of exposure without irradiation).

To extract oil by pressing, a laboratory screw press *KK6–3 was used.* A frequency converter was used to change the screw rotation speed. Changing the thickness of the exit slot at the exit of the press from the press is carried out by a conical device at the end of the press.

The residual oil content of the cake was determined according to the state standard *O'z DSt 2438:2012* Oil seeds. Methods for determining oil content.

The acid number of the oil was determined according to the state standard

O'z DSt 1203:2015 Vegetable oils. Methods for determining acid number.

Analysis of results

The study uses compositional design of experiments (Murray P. M. et al. 2016; Georgakis C., 2013). The changing input factors were the rotation speed of the screw shaft z_1, rpm and the thickness of the outlet slot z_2, mm. These indicators largely determine the value of the pressing pressure, which affects the yield and quality of the resulting oil. The rotation speed of the screw shaft was chosen z_1^- =30 rpm and z_1^+ =40 rpm, and the thickness of the outlet slot z_2^- =6 mm and $z_2^{\mp}$ =10 mm.

The response functions were the residual oil content of the cake, $y_{1,}$% and the acid number of the oil, $y_{2,}$ mg KOH.

The experimental results were processed using mathematical and statistical methods. To assess the homogeneity of variances with an equal number of repetitions of each experiment, the Cochran criterion was used, the significance of the coefficients of the empirical model was determined using the Student's test, the adequacy of the equations was proven using the Fisher criterion (Murray P. M. et al, 2016; Georgakis C., 2013).

Empirical models in coded values of influencing factors were obtained in the following form.

For oil yield: $$y_1 = 11.89–2.02\,x_1 + 0.70\,x_2 + +1.66\,x_1 x_2 +1.23\,x_1^{2}–0.63\,x_2^{2} \qquad (1)$$

For the acid number of the oil: $$y_2 = 1.97+0.28\,x_1–0.34\,x_2–0.4\,x_1 x_2 \qquad (2)$$

We write out mathematical models in natural values of the variables, substituting their expressions through z_i instead of x_i. After performing arithmetic operations, we obtain an equation in natural values of the influencing factors:

For oil yield: $$Y_1 =119.9–5.17\,z_1–2.94\,z_2+ +0.166\,z_1 z_2 +0.049\,z_1^{2}–0.157\,z_2^{2} \qquad (3)$$

For the acid number of the oil: $$Y_2 = = –9.83+0.376\,z_1 +1.23\,z_2–0.04\,z_1 z_2 \qquad (4)$$

Conclusion

Using *Response surface methodology* (Sinha B. K. et al., 2014) and models (3 and 4) we construct response surfaces that take into account the dependence of the residual oil content of sunflower seed mint cake (Fig. 1) and dependence of the acid number of the resulting oil (Fig. 2) on the influencing factors – rotation speed of the screw shaft z_1, rpm and thickness of the outlet slot z_2, mm.

Analyzing the graphs shown in Fig. 1 and Fig. 2, we can conclude that at a shaft rotation speed of n = 35 rpm and outlet slot thickness δ = 7.5 mm, the residual oil content of the cake will be within 10–10.5%; and the acid number of the resulting oil is within 1.65–1.7 mg KOH.

Figure 1. *Dependence of the residual oil content of sunflower seed cake on the influencing factors: shaft rotation speed, n and thickness of the outlet slot, δ*

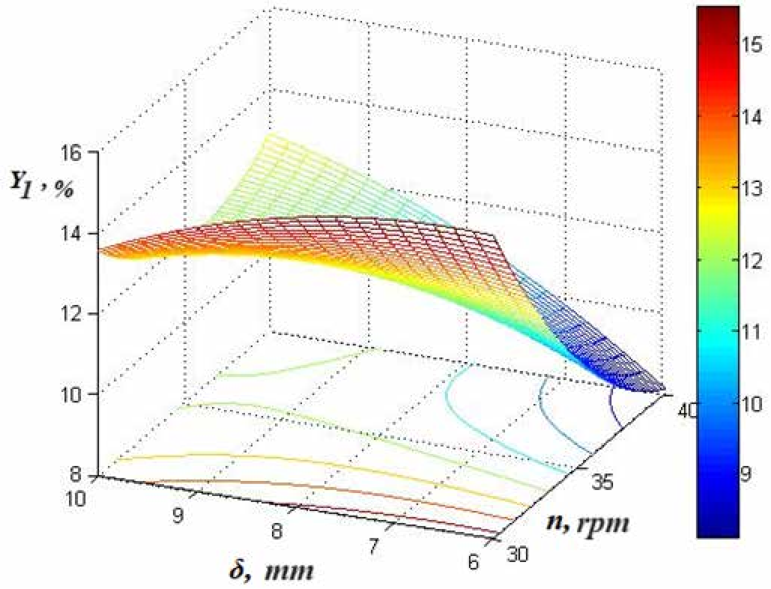
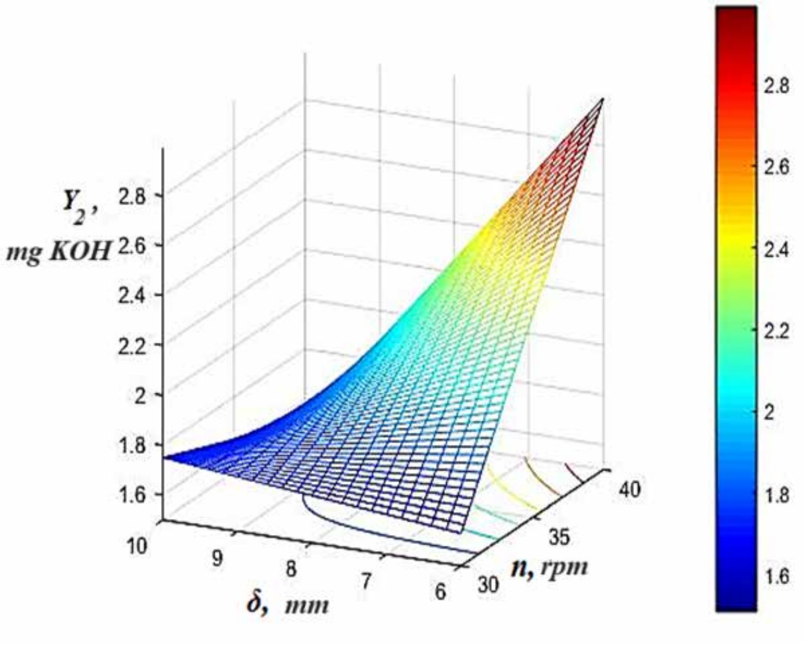


Figure 2. *Dependence of the acid number of the oil on the influencing factors: shaft rotation speed, n and thickness of the outlet slot, δ*



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Contact: kgafurov@yahoo.com

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STUDY OF THERMODESTRUCTIVE CHANGES IN MILK POWDER DEPENDING ON THERMAL EXPOSURE

***Khasan Sagdiyev* [1], *Mokhira Zokirkhujaeva* [2], *Mirolim Aripov* [2], *Ulugbek Kadirov* [2], *Sherzod Mamatov* [3]**

[1] Department of Biotechnology, Tashkent State Technical University;

[2] Department of Food Technology, Tashkent chemical-technological Institute;

[3]Webster University in Tashkent

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Abstract

In this work, we looked at the weight loss of a dry milk sample depending on time with increasing temperature in the range of 80–120 °C. Experimental data on the kinetics of the thermal decomposition process of whole milk powder for conditions of isothermal conditioning of the sample are also presented. The degree of decomposition was determined by the relative loss of mass depending on the time of exposure at constant temperatures, ranging from 80 to 120 °C.

Keywords: *dry milk, whole milk powder for conditions of isothermal conditioning, thermal decomposition*

Introduction

Drying is the most ancient method of preserving milk. During the development of the dairy and canning industry, extensive research was carried out to improve the drying technology, as well as to create agglomerated and rapidly soluble dry dairy products. The composition, properties and structure of dried dairy products, which determine their ability to recover and the nutritional value of recovered dairy products, have been and are being comprehensively studied.

The number of food additives used in the food industry has increased dramatically. The adverse effects of some of them can be diverse both in nature and intensity. Many substances, when ingested for a longer or shorter period of time, especially in combination with other similar substances, even in relatively low concentrations may be far from safe for the body. This adverse effect of food additives can manifest itself in the form of acute or chronic poisoning, mutagenic, carcinogenic or other effects. It is impossible to exclude the possible allergenic effect of foreign food substances, as there is sufficient clinical and scientific data.

Food products of the XXI century are positioned primarily as healthy, so the question arises about the production of milk powder without food additives, by selecting dairy raw materials, changing the composition of the product and regulating technological processes.

In fresh spray-dried milk powder, all the constituent components are fairly evenly distributed in the particle mass. In this case, the continuous phase is lactose, in which fat globules, protein particles and other components are dispersed. More recent studies have established that the continuous phase in the particles can be a protein, which is a porous system of interconnected protein micelles (Ming, J. L. K., Anuar, M. S., How, M. S., Noor, S. B. M., Abdullah, Z., & Taip, F. S., 2021; Saha, D., Nanda, S. K., & Yadav, D. N., 2019). A significant proportion of milk powder particles mainly has a spherical shape and is in a free state. The bulk of the particles has a size of up to 50 microns. A small part of the powder forms agglomerates by combining individual particles with each other. The surface of the particles under the microscope at low magnification appears smooth, glossy and slightly melted. There are crater-like depressions on the surface of individual particles.

During the drying process, the components of milk powder undergo a number of changes, which affects the quality of the product. Changes in milk fat under the influence of temperature concern both its physical condition and chemical composition.

The fat in powdered milk is mostly fairly evenly distributed inside its particles. Electron microscopic studies show that the size of fat globules in the particles of powdered milk obtained from a homogenized product is 0.04–1 microns, and from non-homogenized milk – 5 microns (Babu, K. S., & Amamcharla, J. K., 2022).

Depending on the drying temperature, the size of the fat balls varies. It was also found that when drying milk on the company's direct-flow spray system, the diameter of the fat balls is linearly dependent on the temperature of the air entering the dryer.

The temperature conditions of the drying process also affect the stability of the fat phase of milk. Also, when the temperature of the air entering the direct-flow spray dryer increases from 160 °C to 190 °C, the free fat content increases by 2–3%. Free fat can be found on the surface of the particles in the form of tiny balls and irregularly shaped clusters. Electron microscopic studies show that fat can also be located in the folds of the surface and at the points of contact of particles. The nature of the distribution of free fat on the particle surface is influenced by the presence of micropores, which are channels connecting the particle surfaces with its internal regions, through which part of the free fat can reach the surface (Vincenzetti, S., Cecchi, T., Perinelli, D. R., Pucciarelli, S., Polzonetti, V., Bonacucina, G., Ariani, A., Parrocchia, L., Spera, D. M., Ferretti, E., Vallesi, P., & Polidori, P., 2018).

In our work, we studied the thermodestructive changes in milk powder depending on temperature and duration of thermal exposure.

Objects and Methods

The objects of research at various stages of the work were: – selected whole pasteurized milk with a mass fraction of 3.4–6.0% fat.

The method of identification of the products of the thermal degradation reaction was carried out by the method of absorption spectroscopy.

Absorption spectroscopy is one of the methods of qualitative analysis. The identification of a pure compound is based on a comparison of the spectral characteristics (maxima, minima, inflection points) of an unknown substance and pure compounds; the close similarity of the spectra serves as a good proof of chemical identity, especially if the spectrum of the substance being determined contains a large number of clear, easily identifiable maxima. Spectral studies in the ultraviolet region of the spectrum provide information about the presence or absence of certain functional groups.

There are catalogues of the spectral characteristics of organic compounds in the ultraviolet and visible regions of the spectrum. They are used in the qualitative analysis of organic compounds. The reliability of identification by the absorption method is determined by the number of matching spectral characteristics in the spectra of the compound being determined and the standard.

The identity of the substance to be determined and the standard is confirmed by comparing their spectra obtained at different pH values or after further chemical treatment.

The absorption of functional groups is identified using this method.

The spectra were taken on a spectrophotometer SF-26, in the wavelength range 220–320 nm. The cuvette is 0.3 cm. 100 times diluted raw milk was used as a comparison solution. The object of the study was milk recovered from milk powder samples subjected to thermal exposure in the temperature range of 60–160 °C.

The composition of gases released during decomposition was determined by gas adsorption chromatography on an LHM- ZMD chromatograph with a thermal conductivity detector using aluminum oxide as a sorbent (AlYammahi, J., Rambabu, K., Thanigaivelan, A., Hasan, S. W., Taher, H., Show, P. L., & Banat, F., 2023).

Investigation of the microstructure of milk powder particles. The microstructure of milk powder particles obtained at different temperatures was studied by scanning scanning microscopy using a JEOL JSM – 6390 electron microscope.

Results and Discussion

A series of experiments was conducted to determine the weight loss of a milk powder sample depending on time with an increase in temperature in the range of 80–120 °C. Properly prepared powdered milk retains almost all the beneficial properties and taste qualities of the dairy product. At the same time, the dry concentrate has an extended shelf life and greater compactness during transportation, depending on the main quality indicators of the finished product.

The kinetics of the thermal decomposition of whole milk powder for the conditions of isothermal holding of the sample is shown in Figure 1.

The degree of decomposition was determined by the relative loss of mass depending on the holding time at constant temperatures ranging from 80 to 160 °C. Curves for temperatures of 80, 90 °C characterize a slight loss of mass. At temperatures of 100.110 °C, the process is activated and the mass loss is 15%.

For higher temperatures of 120 °C, the process is characterized by intensive decomposition during the first 60–90 minutes and does not exclude changes in the future. The percentage of mass loss is 27%. The experimental data obtained are shown in (table 1).

Table 1. *Weight loss of whole milk powder samples depending on temperature and holding time*

Variants	Thermostat temperature, °C	Weight loss.%					
		30	60	90	120	150	180
		Exposure time. min.					
experience 1	60	1.0 0.2	1.4 ± 0.2	2.0± 0.2	2.0± 0.2	2.7± 0.2	3.7± 0.2
experience 2	80	2.4±0.2	2.4 ± 0.2	2.4 ± 0.2	3.3 ± 0.2	3.4 ± 0.2	4.3± 0.2
experience 3	100	3.4 ± 0.2	3.9 ± 0.2	4.0 ± 0.2	4.0 ± 0.2	4.1 ± 0.2	4.6± 0.2
experience 4	110	2.8 ± 0.2	3.4 ± 0.2	3.4 ± 0.2	3.7 ± 0.2	4.0 ± 0.2	5.1± 0.2
experience 5	120	2.4 ± 0.2	3.3 ± 0.2	5.4 ± 0.2	6.0 ± 0.2	9.3 ± 0.2	13.2± 0.2
experience 6	130	5.7 ± 0.2	6.3 ± 0.2	9.4 ± 0.2	11.3± 0.2	12.9± 0.2	14.8± 0.2
experience 7	140	7.5 ± 0.2	8.1 ± 0.2	12 ± 0.2	18.6± 0.2	24.1± 0.2	24.7± 0.2
experience 8	150	14.4± 0.2	20.8± 0.2	22.8 ± 0.2	23.7± 0.2	25.5± 0.2	27.2± 0.2
experience 9	160	8.2 ± 0.2	17.5 ± 0.2	23.2 ± 0.2	25.5± 0.2	25.5± 0.2	27.7± 0.2

Based on thermogravimetric analysis and existing concepts, it has been established that the decomposition of whole milk powder begins with the fat-free part of the product. Upon visual observation, whole milk powder after thermal exposure with time exposure thickens, and the color changes from light cream to dark brown already at 110–120 °C.

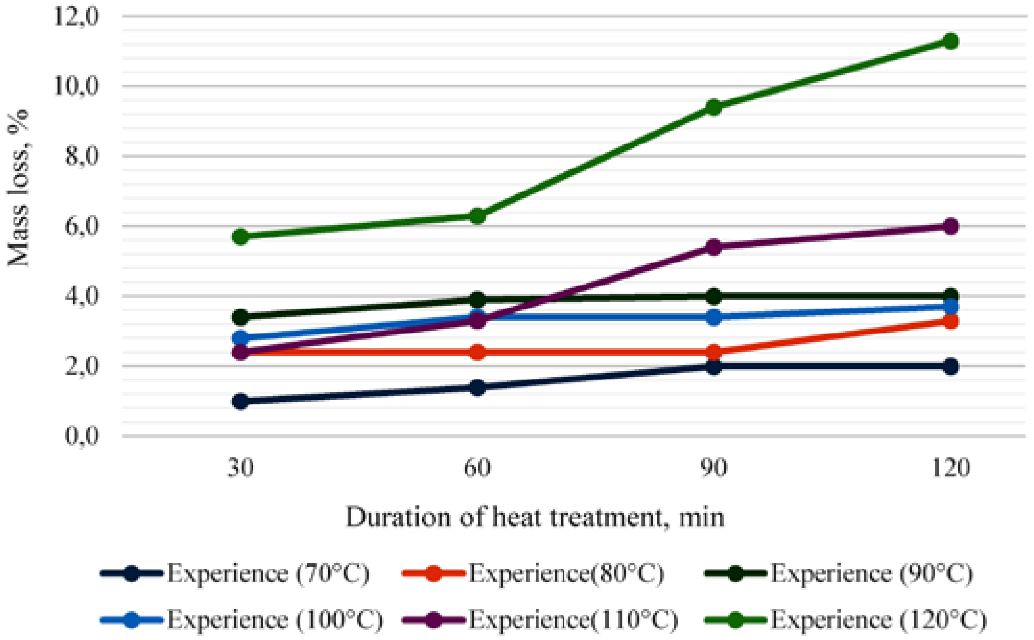
The decomposition process of whole milk powder was also investigated using a differential analysis method.

Analyzing the obtained curves, the following can be noted:

When heated to 110 °C, the mass loss is 9.3%. Heating the product in this zone contributes to the release of water vapor, carbon dioxide, and hydrogen. The maximum rate of mass loss at a temperature of 110 °C. The ongoing processes are endothermic in nature (the curve – DTA goes down from the main position).

When heated from 110 to 146 °C to activate the process of thermal destruction. The maximum decomposition rate is 41.2%. There is a decomposition process, accompanied by the release of heat.

Figure 1. *Mass change depending on the holding time in the isothermal mode*



The temperature range is 146–184 °C. Weight loss is 8.4%. The process is exothermic – the DTA curve rises and reaches a peak at 170 °C.

A noticeable change in mass begins at a temperature of 90 °C. The rise of the DTA curve characterizes the gradual heating of the suspension followed by self-heating, and therefore the development of exothermic reactions. The nature of the TG curve characterizes the activation of the decomposition process, which accelerates to a temperature of 136 °C. Thus, the temperature of 136 °C is characteristic. The maximum decomposition rate characterizes a significant loss of mass. The sharp upward rise of the dTA curve characterizes the predominance of exothermic reactions.

Conclusion

It can be seen from the curves of the differential decomposition rate that the process of thermal decomposition proceeds in stages with clearly defined maxima. The curves shift to the high temperature region.

The processing of the results of the derivatographic analysis consisted in determining the characteristic temperatures according to the DTG and DTA curves, calculating the weight loss of the suspension in characteristic temperature ranges. Temperature extremes on the DTA curve are also quite characteristic. Thus, based on the results of the derivatographic analysis, the following conclusions can be drawn:

– the data obtained by gravimetry and derivatography are quite comparable, although the latter method more accurately and consistently shows the process of thermal decomposition of the product;

– the depth of thermal decomposition depends on the time to reach the temperature and the holding time at this temperature.

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Contact: sherzod_mamatov@mail.ru

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Section 3. Technical science in general

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IMPROVEMENT OF MECHANISMS FOR ANALYSIS OF PRIMARY DATA OF PRODUCT DESCRIPTION BASED ON ARTIFICIAL INTELLIGENCE SYSTEMS

Hamroyev Ulug'bek Rustamovich [1]

[1] Customs Institute of the Customs Committee

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Abstract

In this article, foreign experiences of mechanisms for analyzing the primary data of the description of goods based on artificial intelligence systems in customs control and customs clearance of goods and vehicles (V) transported across the customs border are studied. Also, in the activity of the customs system, suggestions were made regarding its solution by connecting the columns of the customs cargo declaration in order to increase the reliability of the information of the product description of vehicles, to form the integrity of the identification processes on the basis of a logical control system.

Keywords: *product description, brand code, Commodity Nomenclature of Foreign Economic Activity (CN FEA) code, artificial intelligence, product position, foreign economic activity (FEA), vehicle (V), VIN code*

Login

According to Article 21 of the Customs Code of the Republic of Uzbekistan, goods and vehicles (V) transported across the customs border must undergo customs control and customs clearance.

In recent years, many measures have been implemented in our country in order to further develop foreign trade and foreign economic activity (FEA), to create more favorable conditions for FEA participants. Achieving these and similar goals, in turn, requires creating benefits and favorable conditions for entrepreneurs, as well as attracting foreign investments, and introducing simplified, transparent and reliable customs procedures to international standards. In addition, international standards also require the introduction of simplified, transparenFt and reliable customs procedures. An example of this is "On Simplification and Harmonization of Customs Procedures (May 18, 1973 Kyoto). The international convention for the Republic of Uzbekistan, which entered into force on May 16, 2021, can be cited (International Convention, 1973; Customs Code of the Republic of Uzbekistan, 2016).

Analysis

On the other hand, unfortunately, cases of abuse of privileges, preferences and other opportunities created in practice are also noticeable. The legislation also includes actions aimed at eliminating situations that allow significant damage to the state economy for the sake of their own interests by illegal means and false information.

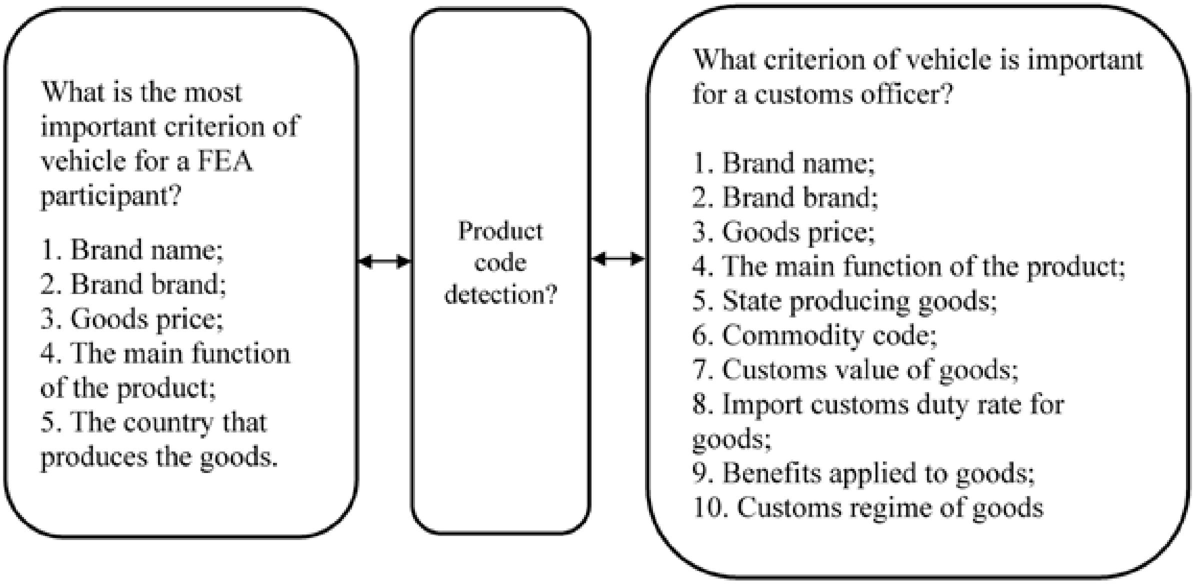
In the Transit Declaration No. 26003/02.03.2022/0018808 in the observation of customs practice "Cars and other motor vehicles designed mainly for transporting people: Lot 31319747 Bought on auxion with water damage, i.e. a recessed used passenger car with an electric damper (Electromobile), model 2020 TESLA MODEL 3, (VIN) № 5YJ3EB1LF647916" when the customs value of the motor vehicle was re-examined, it was revealed that the same VIN was sold for 25,575 US dollars on the websites of vehicle, which sank in digital water. Today, transportation costs for transporting 1 container from the USA to Uzbekistan are 8,000–10,000 US dollars. Taking into account that 2–3 vehicles can fit in 1 container, however, the original technical condition of the vehicle was correctly determined by the customs officer, and the customs value taken as 31,000 US dollars compared to the imported vehicle was calculated correctly. *(https://bidfax.info/tesla/model-3/10766409-tesla-model-3-long-range-2020-blue-dual-vin-yj3e1eb1lf647916.html).*

In customs clearance, the name of the goods or vehicles, the brand of the goods, its technical, chemical, and physical characteristics are the main elements for determining the product code for the FEA participant (Fig. 1).

The CN FEA code of the goods cannot be deliberately chosen incorrectly, of course, in such a situation, the customs officer can have a strong sense of intelligence, vigilance and responsibility, and carry out additional field research.

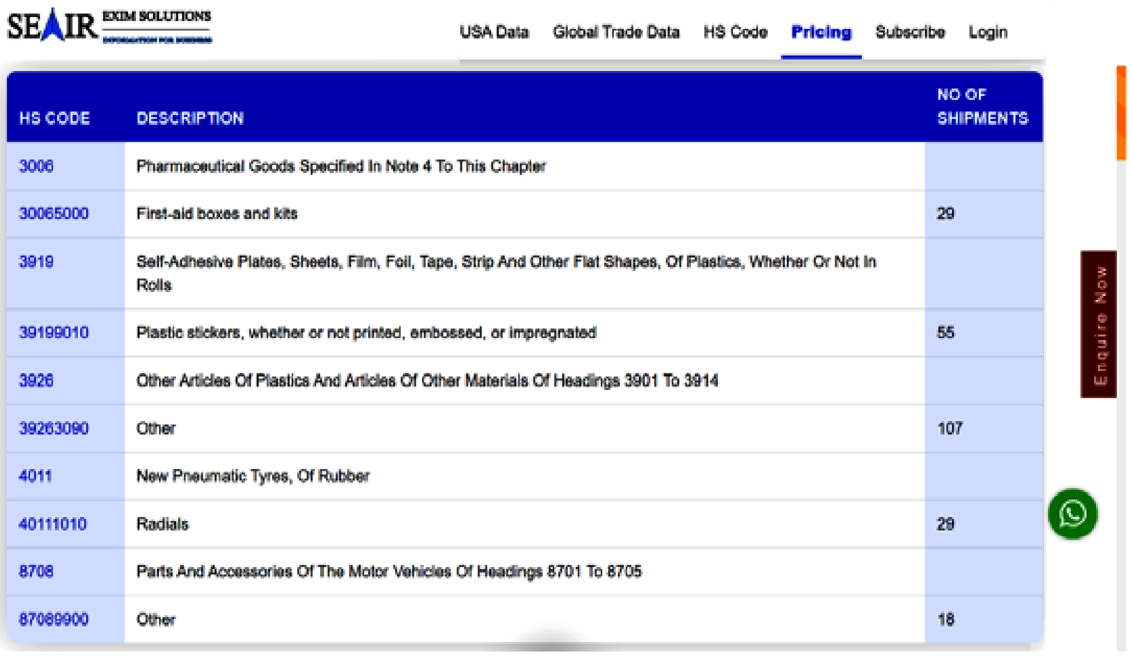
If we talk about the sites of the Republic of India (https://www.seair.co.in/) or World Customs Organization (WCO) Bacuda (https://bacuda.wcoomd.org/#aiHS)), which currently determine the CN FEA code of a product based on artificial intelligence systems (https://bacuda.wcoomd.org/#aiHS; https://tarif.customs.uz/spravochnik/viewDatatable.jsp?lang=en_EN). For example, through the (https://www.seair.co.in/) site, we can also see its CN FEA code and CN FEA codes of other similar goods relatively close to this product and their review (Figure 2).

Figure 1. *Product code determination criteria*



In any case, the CN FEA code of the goods cannot be selected incorrectly, of course, in such a situation, a strong intelligence, vigilance and a sense of responsibility are required from the customs officer. There are social processes in which the human factor is involved, and it is natural that there will be mistakes and shortcomings.

Figure 2. *The result of the product positions according to the text of the Motor sars*



HS CODE	DESCRIPTION	NO OF SHIPMENTS
3006	Pharmaceutical Goods Specified In Note 4 To This Chapter	
30065000	First-aid boxes and kits	29
3919	Self-Adhesive Plates, Sheets, Film, Foil, Tape, Strip And Other Flat Shapes, Of Plastics, Whether Or Not In Rolls	
39199010	Plastic stickers, whether or not printed, embossed, or impregnated	55
3926	Other Articles Of Plastics And Articles Of Other Materials Of Headings 3901 To 3914	
39263090	Other	107
4011	New Pneumatic Tyres, Of Rubber	
40111010	Radials	29
8708	Parts And Accessories Of The Motor Vehicles Of Headings 8701 To 8705	
87089900	Other	18

Table 1 shows the proximity of TIF TN to 5 commodity positions based on this survey.

Table 1.

№	Product position	Comment
1.	3006	Pharmaceutical equipment.
2.	3919	Self-adhesive, in rolls or coils, of plastics in plates, sheets, films, tapes, strips and other flat forms.
3.	3926	Other articles made of plastic.
4.	4011	New tires with pneumatic tires.
5.	**8708**	**Parts and accessories of motor vehicles of headings 8701–8705.**

Figure 2 above analysis data shows the integral proximity of the product to 10 commodity positions.

Bacuda (on the site called https://bacuda.wcoomd.org/#aiHS), through the text of the Motor sars, determines the commodity codes in the CN FEA, which are relatively close to the commodity code (Fig. 3).

By referring to the Harmonized System (HS) code system, we can clearly define the initial product code using the product position review (Harmonized commodity description, 2022).

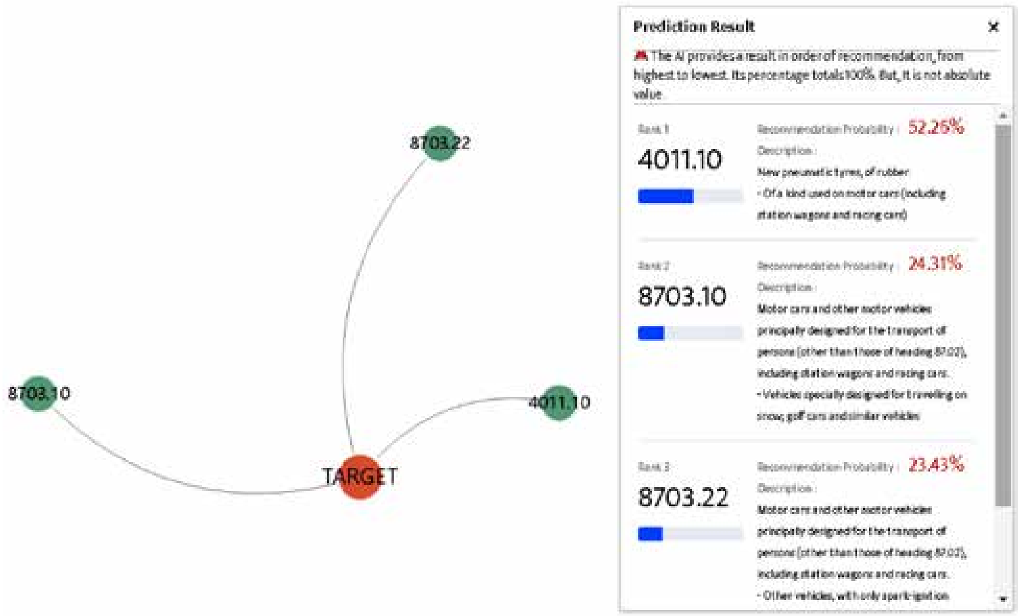
If we pay attention to the results of sites based on artificial intelligence, if you search through the name of the product on the website www.seair.co.in, it will help you to search for the product not only by name, but also by its features on the Bacuda site.

There is also a pricing section on the site, which is an effective approach to avoid artificially inflated or lowered prices. At the same time, it provides practical assistance in ensuring a high level of collection of customs fees in the prescribed manner.

Today, we had the opportunity to determine the product code by analyzing the description of the goods provided by FEA participants based on the artificial intelligence system.

2016 of the State Customs Committee of the Republic of Uzbekistan registered on April 6, list number 2773 "Primary information about vehicle according to the instructions on the procedure for filling out the customs cargo declaration” in column 31 and exit parameters are column 33. “Commodity code” and column 34. “Country of Origin kodib”, column 38. “Netto weight (kg)”, column 41. “Additional unit of measurement”, column 5. “Total number of product names” we can get real information about the product based on the identification logical connection through the VIN code (Instructions on the procedure for filling, 2016; https://www.ahelp.ua/vin.html; Akulova, A.A., 2017). That is, according to each entry parameters of the goods in relation to the product description package, the customs cargo declaration with the authenticity of the goods is directly reliable for the above columns 33, 34, 38, 41, 5. we will provide.

Figure 3. *Analysis of commodity codes with a relative proximity of the CN FEA of vehicle relative to the product position 8703*



Prediction Result ×

The AI provides a result in order of recommendation, from highest to lowest. Its percentage totals 100%. But, it is not absolute value.

Rank 1
4011.10
Recommendation Probability : 52.26%
Description :
New pneumatic tyres, of rubber
- Of a kind used on motor cars (including station wagons and racing cars)

Rank 2
8703.10
Recommendation Probability : 24.31%
Description :
Motor cars and other motor vehicles principally designed for the transport of persons (other than those of heading 87.02), including station wagons and racing cars.
- Vehicles specially designed for travelling on snow; golf cars and similar vehicles

Rank 3
8703.22
Recommendation Probability : 23.43%
Description :
Motor cars and other motor vehicles principally designed for the transport of persons (other than those of heading 87.02), including station wagons and racing cars.
- Other vehicles, with only spark-ignition

Method

Technical characteristics of the TV as an incoming (x) value of column 31 of customs cargo declaration product description, its output (y) value is combined according to (table 2).

Table 2. *VIN code – 1 N4 AZ0CP 2 D C402941 ↔ (1N4AZ0CP2DC402941)*

	x value	**y value**
№	**VIN cody’s review**	**Customs cargo declaration column**
1	1 – Country of manufacture code	34-graph. “Country of Origin code”
2	N – Manufacturer’s name and production department	31-graph product description
3	4 – vehicle type	31-graph product description
4	AZ0CP – Car model and its main features: body type, power supply, transmission system, etc	31-graph product description 38-graph. “Netto weight (kg)” 41-graph. “ Additional unit of measurement ” 5-graph. “ Total number of product names ”
5	2 – inspection code (for cars from the United States)	38-graph. “Netto weight (kg)” 41-graph. “Additional unit of measurement”.
6	D – Year of manufacture	31-graph product description
7	S – Production plant	–
8	402941 – vehicle serial number	31-graph product description

Conclusion:

Therefore, on the basis of artificial intelligence, each descriptive element in the product description package may not be complete or sufficient, but on the basis of each element of the goods, the name of the goods, the brand of the goods, identification according to the main task performed by the goods, as well as the above-mentioned 1st table of the customs cargo declaration The integral connection of the vehicle under the logical control of the VIN code in accordance with the table helps to ensure its authenticity.

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Contact: uzbekiston@inbox.ru

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Section 4. Transport

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WAYS TO CONTROL AND REDUCE HIGH-FREQUENCY LOADS IN OFF-ROAD VEHICLES

Tamaz Morchadze [1], ***Nunu Rusadze*** [1]

[1] Faculty of Technical Engineering, Akaki Tsereteli State University, Kutaisi, Georgia

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Abstract

The paper presents the vibroacoustic control method, and in particular, the following issues are discussed: diagnosis, control, and ways of reducing high-frequency loads in off-road vehicles; determination of optimal clutch damper parameters; improving the design of the transport shaft, and reduction of vibroactivity in the gear transmissions.

Keywords: *resonance; diagnosis; control; vibroacoustics; damper; stiffness; cardan*

Introduction

Throughout the history of the automotive industry, the reduction in load on parts and components of the vehicle as a factor determining reliability has always been of great importance. In this direction, there is an imperative need to intensify the research work at the modern stage, when the production of motor vehicles is rising mainly by increasing the carrying capacity and using high-power internal combustion engines. In such engines, the load mode of the main parts and components of the vehicle, including the transmission, increases. This process requires a more in-depth study of the high-frequency dynamic load of the transmission.

Method

Based on all of the above, it is important to use the vibroacoustic control method to diagnose the technical condition caused by the high-frequency dynamic loads of the vehicle transmission.

To reduce high-frequency dynamic loads, it is necessary:

- to determine optimal clutch damper parameters;
- to improve the design of the transmission shaft;
- to reduce vibroactivity in a gear transmission.

There are many analytical and graphoanalytical methods for calculating the torsional vibration damper in the vehicle transmission. In the case when the damper is placed in the clutch and it is not possible to install it in another place, good results are achieved by the method proposed by Professor P. Lukin (Prof. P. P. Lukin., 1982).

Figure 1 illustrates the dynamic scheme of the vehicle transmission. The a-c link equivalent stiffness and damping coefficients are calculated by the formula:

$$C_{eq} = \frac{F_{\max}(\alpha_1,\alpha_2)}{\lambda_1} = \frac{C_{2-4}}{C_1 + C_{2-4}}\left(C_1 + \frac{M_T}{\lambda_1}\right) \quad (1)$$

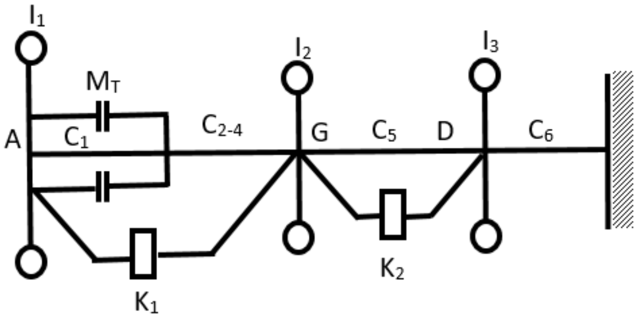
$$K_{eq} = \frac{4.M_T(C_{2-4}\lambda_1 - M_T)}{\pi\lambda_1^2\omega_3(C_1 + C_{2-4})} \quad (2)$$

C_{eq} and K_{eq} coefficients are non-linear functions of the ratio $\frac{M_t}{\lambda_1}$. In addition, K_{eq} is dependent on ω_v vibration frequency (Bugaru, M. & Vasile, A., 2022).

Using the obtained coefficients, we determine the system's natural vibration frequencies. The implication is that $\alpha_1 = \lambda_1 \sin\omega t$ and $\alpha_2 < \lambda_2 \sin\omega t$. The amplitude λ_1 is calculated as follows:

$$\lambda_1 = (1 + ih)\frac{M_t}{C_{2-4}}, \text{where i=1,2,3…., n, h} = 0.25.$$

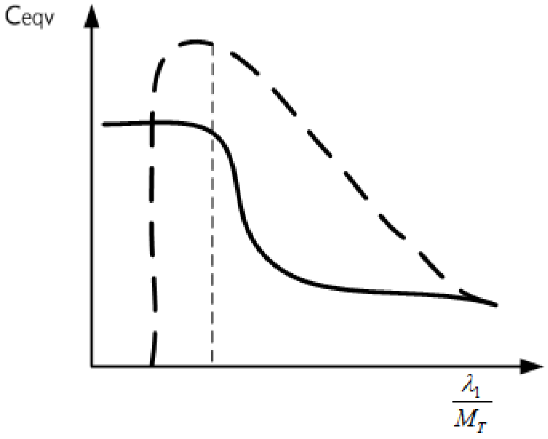
Figure 1. *The dynamic scheme of the vehicle transmission*



Due to the fact that damping has a negligible effect on natural vibration frequency, when calculating the coefficients K_{eq}, their corresponding natural frequencies ($K = K_1 + K_{eq} = 0$) are used. Then, taking into account K coefficients, it is possible to accurately calculate natural vibration frequencies. (Rusadze, T., & lejava, A., & Cirekidze, G. & Feradze, M. & Mamaladze, T. & Gvinianidze, N. 1998).

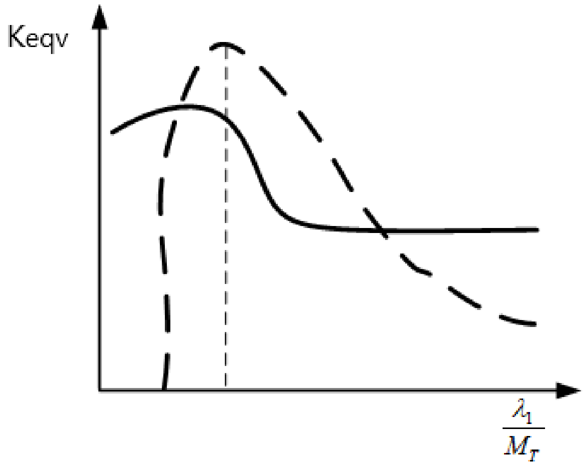
Figure 2 and Figure 3 show the dependence of the coefficients C_{eq} and K_{eq} on the ratio $\frac{K_1}{M_T}$. It can be seen that K_{eq} has a maximum for the value of $\left(\frac{\lambda_1}{M_T}\right)$, at which the largest value of the vibrational energy is dissipated (Bugaru, M. & Vasile, A., 2021)

Figure 2. *The dependence of the coefficient C_{eq} on the ratio of* $\frac{K_1}{M_T}$



According to the results of the calculation of the natural vibration frequencies of the resonance being studied, a diagram (Fig. 3) of the different stiffness and friction moments of the damper is constructed.

Figure 3. *The dependence of the coefficient* K_{eq} *on the ratio of* $\frac{K_1}{M_T}$



In cars and trucks, as well as in some buses, transmission shafts are often used.

Often, in the construction of the transmission shaft, the peculiarities of its operation are not taken into account, in particular, when it has an excess mass that causes vibration in the transmission. (Rusadze, T. P. & Platonov, V. F. & Semenov, V. M. & Gogitidze, A. S. & Rusadze, P. T, 2002).

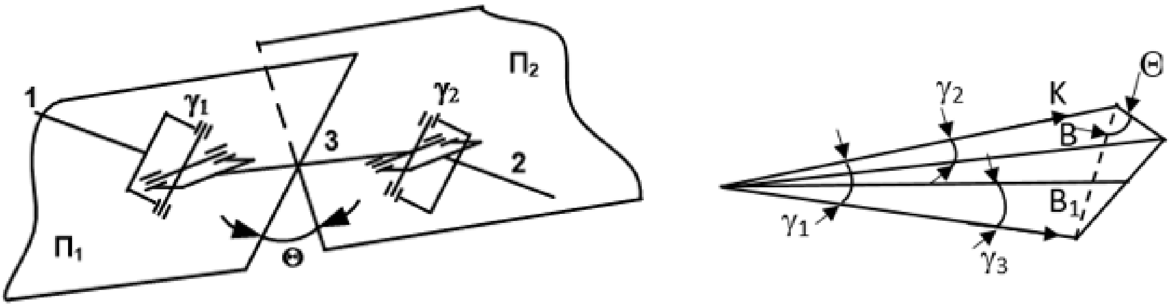
Various new transmission shaft designs to provide the required strength can be based on optimality criteria such as mass, cost, and maximum operational efficiency.

To create a new transmission shaft, we consider it appropriate to correct the angles of hinges of unequal angular speeds and to use hinges of equal angular speeds in the design.

Based on the concept obtained, we developed a new version of the transmission shaft.

Hinges of equal angular speeds and a tube made of composite material were used in the design. The clutch shaft, the primary gearbox shaft, and the transmission shaft itself are not located in the same plane, which causes additional excitation of torsional vibrations due to features of the kinematics of universal joints.

Figyre 4. *A scheme of the double-hinged spatial cardan drive*



On the general scheme of the double-hinged spatial cardan drive shown in Figure 4, the plane Π_1 passes through the drive (1) and cardan (3) shafts, while the plane Π_1 passes through the cardan (3) and driven (2) shafts. If we denote the turning angles of the drive and driven forks of the first joint by φ_3 and ϕ_3', and the angles of the forks of the second joint by ϕ_4 and ϕ_4', then according to: (Florian Ion Tiberiu Petrescu, & Relly Victoria Virgil Petrescu, 2019).

$$\phi_4' = \phi_4 - \lambda_2 \sin 2(\phi_4 + \Theta) + \lambda_2 \sin 2\Theta . \quad (3)$$

In order to reduce torsional vibrations in the double-hinged spatial cardan drive, it is not viewed as necessary to put the angle Θ in the equation. This requirement would be achieved if we set the forks of the cardan shaft in the initial position and perpendicular to the planes Π_1 and Π_2; that is, we will turn the forks at an angle of Θ, or we will turn one of the forks at an angle of Θ towards the other. In this case, no longer terms containing the angle Θ are created in the bond equation because, after the turn, the reference plane of the angle ϕ_4 coincides with the plane Π_2. In the differential equation of torsional vibrations, there will no longer be additional terms containing the angle Θ and it will have the same structure as a "flat" double-hinged cardan drive. That is, in the case of turning forks, the optimal angles for setting a smooth double-hinged cardan drive can be selected under the same conditions as in the case of a "flat" cardan drive.

The angle Θ shall be calculated analytically at the angle between the setting angles γ_1 and γ_2 and the drive and driven shafts (γ_3).

$$\cos\Theta = \frac{\cos\gamma_3}{\sin\gamma_1, \sin\gamma_2} - ctg\gamma_1.ctg\gamma_2. \quad (4)$$

In the special case, when the cardan drive is "flat", that is, a plane can be drawn on all three vectors, then by inserting the value of γ_3 into the equation, we will obtain that cosΘ = 1, or Θ = 0.

If, as a result of the calculation, the value of the angle Θ according to the above formula (4) is obtained with a negative sign, which corresponds to an obtuse angle, then the drive fork of the second joint lags behind the plane Π_2 during rotation, and it must turn at an angle Θ in the direction of rotation of the cardan drive, or vice versa, the driven fork of the first joint must turn in the direction opposite to the rotation of the cardan drive (https://www.researchgate.net/).

If the result in equation (4) is obtained with a positive sign, in this case, the drive fork of the second joint turns in front of the plane Π_2, and it must turn at an angle Θ in the direction opposite to the rotation of the cardan drive (or the driven fork of the first joint must turn in the direction of the rotation of the cardan drive).

In this case, when $\gamma_1 = 2^0 39'40''$, $\gamma_2 = = 3^0 34'11''$, and $\gamma_3 = 5^0$, we obtain $\Theta = 87^0 04'$.

When $\gamma_1 = 3^0 04'540$, $\gamma_2 = 3^0 06'44''$, and $\gamma_3 = 5^0$,– $\Theta = 86^0 45'$.

That is, the driven fork of the first joint must be rotated in the direction of rotation of the cardan drive at an angle of $87^0 04'$ in the case of an angular structure, or at an angle of $86^0 45'$ by changing the installation angles.

Both straight and helical gears are used in off-road vehicle transmissions and gearboxes.

One of the well-known ways to reduce dynamic loads is to increase tooth deformation when entering the coupling phase, which would be achieved by increasing overall tooth compliance or increasing compliance at the coupling points (for example, increasing tooth height or reducing tooth cross-section).

Result

The excitation of vibrations in the straight-toothed gears is a powerful source of the periodic change in stiffness according to the coupling phase. If we assume that the stiffness of coupling is proportional to the total length of the contact lines, then it is possible to achieve constancy in the total length of the lines in the straight-toothed gear.

In a helical gear, the stiffness is constant according to the coupling phase, if the helical overlap factor is an integer. However, despite the product of the area of the tooth crown on the axial pitch, there is still a second source of vibration – the error of the toothed gear wheels on the circular pitch, which causes the teeth to enter the non-working point, or out of the coupling line.

The method of mutual compensation of the exciting forces is known, the essence of which is the rational selection of the phase between the two mentioned factors – the change of the hardness of the teeth according to the coupling phase, and not the periodic entry of the teeth into the working point.

Discussion

In order to reduce the dynamic forces, it is also possible to make the gear with a composite structure. The elastic element installed between the gear hub and the rim will resist the propagation of vibration, and due to the elastic-damping properties, the vibroacoustic characteristics of the gear transmission will be improved.

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Contact: nunu.rusadze@atsu.edu.ge

Contents

Section 1. Chemistry

Section 2. Food procceding industry

Section 3. Technical science in general

Section 4. Transport