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Technical and Economic Features of Cotton Plant Biomass

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ABSTRACT

The purpose of this message was the characteristics of raw cotton and its energy potential as a renewable energy source (RES) and technical and economic features. Use and application of solid residues from cotton biomass and the production of various types of biofuels (bioethanol and biodiesel fuel) and other products for economic sectors for the sustainable development of Turkmenistan.

Relevance of the Problem

The existence and further development of modern civilization requires expanded production and consumption of energy. Currently, the main sources of energy are fossil resources, which satisfy more than 80% of the world's energy demand. Recently, increasing attention has been paid to research in the field of alternative energy sources, in particular, the use of plant biomass, which, unlike mineral sources, is constantly renewed in nature. Currently, biomass accounts for about 10% of global energy consumption. Some types of plants, as well as waste from the forestry, woodworking, textile and pulp and paper industries, agriculture and cities can serve as raw materials for the production of biofuels. The total amount of such raw materials accumulated in the world per year is about 1 billion tons. To produce energy, biomass can be used directly as solid biofuels or converted into liquid biofuels - bioethanol or biodiesel. Increasing the volume of production of various agricultural products, developing the agro-industrial complex, rational use of land and water, breeding work, breeding new varieties of cotton, and the scientific basis for increasing their productivity will ensure food abundance in the country. This is a strategic guideline and the most important priority pursued by the President of Turkmenistan Serdar Berdimuhamedov.

Cotton Biomass Priorities in Turkmenistan

The most profitable area for using plant biomass in Turkmenistan as a renewable energy source for energy production is the energy potential of cotton. In Turkmenistan, the main production of the agricultural complex is cotton, as can be seen from the research and analysis carried out, the following can be said. Cotton is a valuable spinning crop. Its fiber is used for the production of a variety of fabrics - calico, cambric, voile, knitwear, as well as for the production of threads, cord, celluloid, photographic film, and valuable types of paper. When mixed with man-made fibers or wool, cotton fiber is used to make various fabrics. Linter (down) is used to make batting, artificial felt, cellulose, plastic, photographic film, and varnish. From 1 ton of raw cotton the following is obtained: fiber 330-360 kg, seeds 550-580 kg, linter 30-40 kg. Cotton seeds contain 20-25% oil, used in the food, canning and perfume industries, for the preparation of margarine, glycerin, drying oil, and machine oils. From gossypol, obtained by refining oil, medicines, dyes, and heat-resistant varnishes are obtained. From 100 kg of seeds you can get up to 19-20 kg of oil and up to 42 kg of cake. The cake contains 35-40% protein, but it must be used carefully for animal feed due to the glucoside content - gossypol . Cotton husks, separated from the kernel, are used to produce industrial alcohol, cardboard,

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plastics, and lignin. Dry stalks (guzapaya) after cotton harvesting are used for fuel. After processing, crushed stems and boll valves are used as livestock feed. Cotton is a valuable honey plant.

As a row crop, it is of great agrotechnical importance. The world cotton sown area is over 33 million hectares, the gross harvest of raw cotton is more than 45 million tons. The average yield of raw cotton in the world in 1982 was 1.37 t/ha. The main cotton-growing countries in the world are the USA, China, India, Pakistan, Brazil, Mexico, Egypt, Uzbekistan, Turkmenistan and Turkey. The main cotton growing areas under the Soviet Union were Central Asia (Uzbek SSR, Turkmen SSR, Tajik SSR, Kirghiz SSR), Kazakhstan and Transcaucasia (Azerbaijan SSR). The area sown with cotton was 3.2-3.3 million hectares, the yield of raw cotton was 2.58 t/ha (1984), the cotton growers of the Uzbek SSR achieved high levels, receiving 3.14 t/ha in 1983. ha. The cotton genus Gossypium includes 35 species, of which only 5 are cultivated. Two types of cotton are cultivated in Turkmenistan : common or Mexican (medium-fiber) cotton - Gossypium hirsutum L., and Peruvian or Egyptian cotton (fine-fiber) - Gossypium barbadense L., more thermophilic with a long growing season; it is cultivated in the southernmost cotton growing regions. As of 1986, 26 varieties of ordinary and 12 varieties of fine-fiber cotton were zoned. Cotton varieties must have a set of important biological properties, high yields and meet the fiber quality requirements of the textile industry. The most common varieties are: medium-fiber - 108 F, Tashkent 1, Tashkent 6, S-4727, Kzyl-Ravat, 149F, Regar 34; fine fiber - S-6037, 5904-I, 9647-I, Ashgabat 25.

Biotechnological Features of Cotton

Cotton is one of the most labor-intensive row crops. Integrated mechanization makes it possible to effectively use the entire arsenal of means for the targeted cultivation of cotton. Favorable conditions have been created for performing all harvesting, procurement and processing operations in a single flow. For example, to collect just one kilogram of raw meat, you need to extract it from 250-300 boxes. Cotton fiber consists of 94-95% cellulose, which when combined with nitric acid produces esters. By changing the amount of the reagent acting on it and the reaction conditions, it is possible to obtain nitrocellulose with different nitrogen content. Colloxylin, which contains 10.7-12.2% nitrogen, is used for the production of celluloid, plastics (etrols), nitro adhesives and nitro enamels, etc. Cultivated cotton plant for the sake of the fibers that cover its seeds and represent, when purified from the latter, the so-called cotton paper, cotton or cotton wool. Herbaceous cotton is grown in almost all cotton-producing countries, especially in the East Indies, Persia, Asia Minor, southern Europe (southern Italy and Spain), Egypt and North America, in Central Asia and the Caucasus. In addition to the above, several other types of cotton are cultivated, of which the most important is Gossypium barbadense L., growing wild in the West Indies and cultivated in many tropical and subtropical countries; it produces a variety of West Indian cotton known as “Sea Island”, which is distinguished by the special length of its fiber, reaching 4.05 cm according to Wiesner. Cotton cultivation is possible in countries with a warm, humid climate and an average annual temperature of 19-20 °C (15-20 °R.).

For good growth, cotton requires soil rich in humus, potassium and lime salts, good irrigation and, as just mentioned, a mild climate; To obtain a good harvest, dry weather is necessary during the harvest. Cotton is grown from seeds by sowing in such a way that holes are made in the soil at a distance of 1 m (31/3 ft) from each other, into which several seeds are placed. After the seedlings have sprouted, the weakest of them are weeded out; after some time (after about 2-3 months), the tops of the stems of young plants are cut off, which causes them to become more bushy, giving a bountiful harvest. The latter begins 4-5 months after sowing and continues, since the fruits do not ripen simultaneously, in many countries up to 4 months. Cotton is harvested from fully mature, i.e., from opened fruits (bolls), when the seeds, wrapped in hairs (cotton), have already emerged somewhat from the fruit nests enclosing them. The contents of the boxes are removed by hand and dried for some time in the sun; after that, the cotton is cleared of seeds by special machines (Egreniermaschienen), subjected to the action of a hydraulic press and packed into hemp or jute bags in bales of approximately 200 kilograms (about 121/4 pounds) in weight.

A large, well-developed plant can yield up to 1 kilogram (2 1/2 lb) of raw cotton. From the seeds remaining after cleaning, fatty oil is extracted by squeezing, obtained in an amount of 20-40%, which is used for soap making and for counterfeiting olive and other oils. It should be noted here that in America the cakes obtained by squeezing oil have not gone unused: for some time they have been delivered from there in huge quantities to the European market as feed for livestock. However, rural owners should be warned against such use of cakes, since cotton cakes contain a toxic substance that has not yet been chemically studied. Even with very small portions of the said cakes, given for a long time with food to sheep and calves, these animals lost weight and died exhausted (cachectic) and with signs of dropsy; an autopsy showed severely altered kidneys, highly affected by parenchymal nephritis. When feeding in somewhat larger portions, acute gastrointestinal distress with bloody diarrhea and bloody urine soon appeared. Cotton is one of the most labor-intensive row crops. Integrated mechanization makes it possible to effectively use the entire arsenal of means for the targeted cultivation of cotton. Favorable conditions have been created for performing all harvesting, procurement and processing operations in a single flow. For example, to collect just one kilogram of raw meat, you need to extract it from 250-300 boxes.

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form the basis of explosives. Cotton seeds are rich in oil, which has high nutritional benefits. For Central Asia it is the main type of vegetable fat. The seeds are not only oily, they are also rich in proteins, just like sunflowers. Cotton seed flour contains: lysine, arginine, histidine, aspartic acid, threonine, serine, glutamic acid, proline, glycine, alanine, valine, methionine, isoleucine, leucine, terosine and phenylalanine. Cotton husks also produce ethyl alcohol, which is a source of many compounds. The stems and leaves of the cotton plant are a source of methyl alcohol and acetic acid; special paper, filters, and cardboard are made from them. It is also possible to obtain composite materials, which from 1 ton will release 10 tons of metal.

Biomass-Derived Materials

The following materials were used and studied: sawdust of poplar wood of the Populus species Canadensis; agricultural waste: wheat and rice straw, cotton; sugarcane bagasse; fallen and pressed olives; used newsprint and printed paper, corrugated cardboard; cotton and textile industry waste; residual lignin isolated from poplar wood after acid hydrolysis; residues from enzymatic hydrolysis of pre-treated woody biomass; pure cotton pulp

Waring" mill, passed through a sieve to obtain a fraction with a particle size of 1-3 mm and then dried at 110 ^{o}C to constant weight.

Energy Ability

The chemical composition of plant materials and waste was studied using standard methods. The number of repetitions was three. The standard deviation in determining the percentage of components was, on average, ±1%. The standard enthalpy or higher heat of combustion (E) of plant materials, their individual components, oils and liquid biofuels was determined using a Parr 6400 bomb calorimeter at 25 ^{o}C in accordance with ASTM D240 [1]. A study of the chemical composition of dried plant materials showed that the largest amount of cellulose (95-98%) contained textile and cotton waste, and the most lignin (33-37%) was contained in pressed olives and wood biomass residues after enzymatic hydrolysis. The lowest calorific value, 11-13 MJ/kg, was found in samples of biomass with high ash content - waste printing and newsprint paper, as well as rice straw. The heat of combustion of the remaining samples of plant materials occupied an intermediate position and ranged from 15 to 18 MJ/kg. The calorific value of cotton depends on the moisture content of the stem, which varies from 8 to 70% in terms of kWh per 1 kilogram from 1 to 4.5 kWh/kg or in kilocalories per kilogram from 7 to 4000 kcal/ kg.

Use in the Medical Industry

Are used for medicinal purposes, but cotton seed oil is also suitable, at least for the preparation of external remedies. Ordinary commercial cotton (cotton paper or cotton wool) has a slightly yellowish or greenish color, but purified cotton should be completely white, odorless and specific gravity = 1.4. To obtain purified cotton, also called absorbent cotton, wash plain cotton paper first in a warm 3-4% soda solution (Natrum carbonicum) and then in clean water. Refined cotton seed fatty oil is a straw-yellow liquid, specific gravity = 0.922-0.926 and has a nutty taste [2].

Essential Components

cotton or cotton wool consists of fiber, and ordinary cotton wool also contains a small amount of fat, traces of protein (plasma residues), mineral salts, up to 1.83%, (according to Wiesner) and in a dry state up to 7% water. Purified, i.e., absorbent cotton wool consists of pure fiber; the aqueous extract from it, evaporated to dryness, should not leave any residue. Cotton root bark (*Gossypium hebraceum L.*) contains, according to Drueding, red and yellow resin, fatty oil, gum, sugar, tannin, chlorophyll and 6% mineral salts, in addition, cotton acid (Acidum) is found in the bark gossypicum - see Dragendorff, 426). The seed produces fatty oil when cooled below 12°C, cotton stearin (cotton margarine), the rest of the liquid part of the oil consists mainly of triglycerides of palmitic, oleic, linoleic and linolenic acids; in addition, it contains a small amount of hydroxy fatty acids and an aldehyde-like, unsaponifiable substance; unrefined oil has a dark brown, almost black color , due to the presence of a special pigment in it – gossypin [3].

Pharmaceuticals

Purified or absorbent cotton wool - Gossypium depuratum (or *G. hygroscopicum*); it is also impregnated with various substances: *Gossypium benzoicum*, *G. boricum*, *G. carbolisatum*, *G. corrosivum* (otherwise *G. cum Hydrargyro bichlorato corrosivo*), *G. haemostaticum*, *G. ichthyolatum*, *G. jodatum*, G. jodo-formiatum, *G. jodolatum*, *G. salicylatum*, *G. thymolatum* and many others. etc.; cotton wool - Gossypium fulminans or Colloxylinum (represents trinitrocellulose = $C_{12}H_{17}O_7(NO_2)_3O_3$ and is obtained by treating purified cotton wool with a mixture of sulfuric and nitric acids, followed by washing with water), various collodions are prepared from it - Collodium (ethereal solution of buckwheat), *Collodium cantharidatum* (blister collodion), *Coll. cogrosivum* (with sublimate), *Coll. elasticum* (with glycerin), *Coll. jodoformiatum* (with iodoform), etc.; purified cottonseed fatty oil – Oleum Gossypir rafinatum; cotton root bark - Cortex radicis Gossypii hebracei , extracts are prepared from it - Extrastum fluidum Gossypii herbacei (from fresh bark) and Extr . Gossyp. herbac. spirituosum (spissum and siccum). In addition, pharmacies stock various gauze and gauze bandages, also made from cotton paper [4].

Medical Use

Cotton wool, gauze and gauze bandages play a very important role in modern surgery as dressing materials. Collodion is used to lubricate the skin during ulcers, abrasions, minor bleeding, chills, erysipelas, inflammation of the skin, etc.; due to the rapid evaporation of the ether contained in the collodion, it quickly dries and forms a glossy, tight-fitting protective film on the skin; to give this film greater elasticity, add glycerin, castor oil or turpentine to the collodion. Cotton seed fatty oil is suitable for preparing ointments and plasters. Cotton root bark and extracts from it are very common remedies in America, which have now come to us. This bark acts in large single doses like ergot (see 140. Claviceps purpurea Tul.), increasing efforts and stopping bleeding from the female genital organs; with small doses and prolonged use, the opposite effect is obtained, i.e., bleeding increases; therefore it is used as abortivum, haemostaticum, emmenagogum and antispasmaticum.

Technical and Economic Features of Oil Seeds

The main raw materials for the production of vegetable oils are the fruits and seeds of plants belonging to the oilseed group. The most important oilseed crop in our country is cotton. Along with this, much attention is paid to the processing of soybean, sunflower, safflower, and rapeseed seeds, from which edible oil and high-protein meal are obtained. Cotton plant belongs to the mallow family. Currently, cotton breeding is aimed at obtaining varieties with maximum yield of high-quality fiber. Therefore, the content of oil and seed coat in seeds has remained practically at the same level for decades, despite the emergence of new varieties: seed oil content is 17...24%, hull content (seed coat content) -40...44%. More than 35 types of cotton are known, of which two types are most widespread in Turkmenistan: medium-fiber and fine-fiber. The zoning of certain varieties of cotton is carried out taking into account observations of the yield, resistance to plant diseases of each cotton variety in different soil and climatic conditions. A suitable variety is sown in each region of the country, for example, in northern Dashoguz , preference is given to the varieties “Dashoguz-120”, “Serdar”, “149-F”, etc., Mary and Lebap have approximately the same soil and climatic conditions, so “Ash-36” is grown , “133-F”, “Elaten-14”, “Elaten-39”, in Ahal specializes in growing fine-fiber varieties.

After the cotton fiber is removed at cotton gin plants, a significant amount of short cotton fiber remains on the surface of the seeds in the form of fluff and fluff. Cotton seeds are divided into four industrial grades - I, II , III and IV. Fully mature seeds are classified as grade I, immature and puny seeds are classified as grade IV. Chemical composition of seeds of one of the cotton varieties (in terms of absolutely dry matter). In accordance with the current standards in our Republic, industrial cotton seeds (industrial ¬raw materials) of grades I... IV have a moisture content of 8.7...14.9%; content of weed and oilseed impurities 1.0...23.0%; pubescence 6.7...10.5%. A specific feature of cotton seeds is the presence in them of a highly toxic chemical compound - gossypol. Gossypol is a nerve poison for animals and humans. When processing seeds, it turns into oil, cake and meal. Removing gossypol from these products is mandatory. Depending on the cotton variety, climatic and soil conditions of the growing zone, the degree of maturity, the nature of agricultural activities, in particular, the amount and composition of fertilizers, the fatty acid composition and physicochemical characteristics of cottonseed oil fluctuate somewhat. For example, the iodine number of cottonseed oils ranges from 98 to 118 % J2, the content of linoleic acid is from 40 to 50%, oleic acid – 15-20%, palmitic acid – 16 to 24%, stearic acid – 0.5 to 4%. The composition of cottonseed oil, in addition to triacylglycerides and free fatty acids, includes its accompanying substances: phosphatides in amounts ¬up to 2%, sterols - up to 0.3%, tocopherols - up to 0.14% and carbohydrates - up to 0.25%.

The composition of cottonseed oil also includes a complex of pigments - gossypol and related coloring substances, which distinguish cottonseed oil from all other vegetable oils. The presence of gossypol, which tends to transform into a modified form under the influence of moisture-heat treatment and also bind to proteins and phosphatides, forming gossyproteins and gossyphosphatides, causes the dark color of raw cottonseed oil. The usual method of processing cotton seeds does not use gossypol and its derivatives, which are of ¬significant interest to the national economy, since they can be used as antipolymerizers and antioxidants ¬in the production of thermosetting resins, plastics, antiseptics, wood, pharmaceuticals, foundry dyes and etc. All these possibilities for the use of gossypol and its derivatives prompt us to look for methods for their isolation, especially gossypol in its native form. These circumstances determine the ongoing search for ¬new technological schemes for processing cotton seeds, which would make it possible to make maximum use of all components of the seed and at the same time obtain high-quality oil, meal and cake. Taking into account the relationship of the technology we propose with the nature of the substances that make up the kernel, the seeds, we will briefly characterize the substances accompanying the oil.

Gossypol and its Derivatives

Among the substances accompanying oil extracted from cotton seeds, gossypol and its derivatives are of particular interest, since they have a significant impact on the quality of oil, cake and meal. Gossypol is a specific yellow pigment of cotton. The content of gossypol in the kernel of cotton seeds ranges from 0.38 to 1.56% by weight of the dry and defatted kernel, but there are some types of cotton with significantly less or significantly more content of gossypol. Fluctuations in the content of gossypol in the kernel depend on many factors, in particular, on varietal differences in seeds, the degree of their maturity, etc. Gossypol in the kernel of cotton seeds is localized in special glands. The walls of the glands, according to V.P. Rzhekhin, have very high strength. When grinding dry kernels (humidity 5...6%) on roller machines, they are only partially destroyed. The walls of the glands are resistant to many organic solvents. However, low molecular weight alcohols, aqueous acetone and water cause their rapid destruction. Pure gossypol is a lemon-yellow crystalline substance with a melting point of 184 ^{0}C. Gossypol is highly soluble in low molecular weight alcohols, chloroform, ethyl ether, acetone, less soluble in gasoline, cyclohexane, glycerin, and not at all soluble in water and petroleum ether. Gossypol dissolves in oils, especially when heated, and gasoline -oil mixtures (miscellas), so during extraction it turns into oil [5].

Gossypol in the crystalline state is a fairly stable compound. This is a polyfunctional compound, the molecule of which contains two aldehyde and six hydroxyl groups; of these latter two, located in the ortho position with respect to the aldehyde groups, are acidic in nature. A.L. Markman and S.N. Vilkova [6] attribute acidic properties to hydroxyls located in the peri-position relative to carbonyls. Tautomeric forms of gossypol change from one type to another under the influence of technological factors. Gossypol with concentrated sulfuric acid turns scarlet; in an aqueous solution of ferric chloride – olive green; with nickel acetate - purple; with tin chloride - purple-red; with antimony chloride - red. These reactions are characteristic of gossypol. All six hydroxyl groups of gossypol react with alcohols, forming the corresponding esters, the reaction with acids leads to the formation of esters (acetates, palmitates, etc.) Gossypol, as a weak acid, reacts with alkalis, and forms salts insoluble in oils and miscellas - gossypolates. Hydrogen atoms of naphthalene nuclei lying in the 4,4-position react with diazo compounds (for example, with diazotized aniline, para- nitroanaline, sulfanilic acid, etc.), forming the corresponding combination products - azo derivatives of gossypol The aldehyde groups of gossypol, located in the 8,8-position, react with ammonia and various amino compounds such as proteins, phosphatides, aniline, aminobenzoic acids, etc. The currently used methods for the quantitative determination of gossypol in seeds, oil, cakes, meal and other objects are based on this reaction. In addition, this reaction is used for the industrial isolation of gossypol as anthranilate gossypol from oil and miscella.

Gossypol in solution, especially in the presence of dissolved oxygen or peroxides, quickly oxidizes and changes into an altered form, losing the ability to react with aniline to form dianiline-gossypol. V.P. Rzhekhin experimentally proved the easy oxidation of both crystalline gossypol when heated in air, and, in particular, dissolved gossypol. At the same time, in the solid state, with increasing temperature, its neutralization number decreases, aldehyde groups disappear, and heated preparations darken. A.L. Markman and S.N. Vilkova also studied the nature of the change in gossypol when heated in a dry state in air and its oil solutions. In the first case, prolonged heating, although it leads to a change in the color of gossypol, however, it does not lose its ability to dissolve in alkalis; in the second case, it goes into an insoluble form, which means the disappearance of acidic properties: gossypol goes into an altered form. Having developed a polarographic method for the determination of gossypol in alkaline extracts, the author came to the conclusion that the change in gossypol is influenced by both temperature and duration of heating. The higher the heating temperature of gossypol, the more contact it has with oxygen, the deeper and faster the changes occur. This change in gossypol also occurs during the processing of cotton seeds.

This is extremely undesirable, since the gossypol derivatives formed in this case are extremely difficult to remove from the oil during its refining: to remove them, it is necessary to spend a larger amount of alkali, since the changed gossypol is apparently removed only due to its sorption on the surface of soap flakes. The use of large excesses of alkali during refining leads to a decrease in the yield of refined oil. When heating moistened cotton wool gossypol interacts with protein substances to form compounds insoluble in oil and organic solvents - gossyproteins. The higher the degree of crushing of the kernel and its moisture content, the faster and deeper the binding of gossypol with protein substances occurs. The greatest binding effect is achieved when the moisture content of the cotton kernel is 12...15%. With increasing heating temperature, the strength of the bond between gossypol and amino acids increases. The interaction reaction begins at 100 ^{0}C and above. The products that combine gossypol with amino acids are very strong; gossypol is released from them when heated with aniline. R.P. Rzhekhin and his colleagues found that when heating solutions of phosphatides and gossypol, intensely colored resinous substances are formed that have properties different from gossypol and phosphatides. The same was observed in an oil environment.

T.K. Semendyaeva confirmed the fact of interaction of phosphatides with gossypol when heated in concentrated miscellas . A.L. Markman and A.U. Umarov were the first to isolate gossyphosphatides from crude cottonseed oil using the chromatographic -method. Under production conditions, the formation of gossyphosphatides due to the interaction of phosphatides with gossypol is possible during the moisture-heat treatment of mint in roasters, during the process of squeezing oil in presses and during the distillation of miscella. Analysis of the structure and assessment of the properties of gossypol show that gossypol is one of the main components of cotton, which significantly affects the quality of crude oil, cake and meal during seed processing. Therefore, inactivation Gossypol in the process of processing cotton seeds remains one of the main ways to improve the quality of crude oil, cake and meal. However, these methods do not fully ensure the removal of gossypol and the reduction of its content in the composition of raw materials or crude oil. Thus, the complex structure and increased reactivity of gossypol may determine its changes and interactions at all stages of cotton seed processing. In this regard, one of the objectives of this work is to study the change in free gossypol when cotton mint is treated with solutions of sodium hydroxide and calcium chloride of various concentrations, activated in an electromagnetic field, depending on the initial content of substances accompanying it. During the technological processing of cotton seeds, along with gossypol, phosphatides have a huge impact on the quality of the products.

Phosphatides

Among the substances accompanying oils, phosphatides occupy an important place. They are glycerols in which two hydroxyls are esterified with high molecular weight fatty acids and one hydroxyl is esterified with phosphoric acid bound to an amino alcohol. Studies have shown that in oilseeds phosphatides are found mainly in the gel phase and in smaller quantities in the oil phase. The content of phos-

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phatides in oil seeds (based on the weight of the dry kernel in %) of sunflower is 0.84; cotton -1.25...1.75 and soybean - 0.92...1.60. The content of phosphatides converted into oils depends on the method of seed processing. For example, cottonseed oil obtained by prepressing -contains 1.0...1.7% phosphatides, and extraction oil contains 1.4...1.8 %. Phosphatides are highly soluble in most organic solvents, in particular ether, benzene, chloroform, methanol, etc., and poorly soluble in acetone and methyl acetate. The insolubility or limited solubility of phosphatides in acetone is used for the purification of crude phosphatides and in the practice of analytical chemistry. Phosphatides do not dissolve in water, but swell, as a result of which their solubility in oil decreases. The water content of the processed material affects the solubility of phosphatides in the oil during extraction. This property is based on the release of phosphatides from vegetable oil by hydration, which leads to a decrease in the acidity and color of the oil.

Other authors believe that the decrease in oil acidity during hydration occurs not only due to the adsorption of free fatty acids on the surface of phosphatides, but due to the fact that phosphatides are titrated with alkali in the same way as free fatty acids. Due to the fact that phosphatides contain free functional groups, they can interact with other substances during the oil extraction process, including, as mentioned above, with gossypol to form dark-colored gossyphosphatides. V.P. Rzhekhin and I.S. Preobrazhenskaya studied the reaction of interaction of phosphatides with sugars in the presence of water, in an oily medium, in an atmosphere of air and carbon dioxide. They called the dark-colored products formed melanophosphatides. Thus, it can be assumed that phosphatides can change in quantitative content in crude oil when using a combined ¬oil extraction and refining technology.

Carbohydrates

Carbohydrates are polyhydric alcohols and are found in all oilseeds. The carbohydrate content of oil seeds varies widely. Mono- and disaccharides are usually found in small quantities, polysaccharides in large quantities, and sometimes are the main component of the seed. According to literature data, the amount of monosaccharides in the kernel of sunflower seeds ranges from 0.31...0.48% and cotton - 0.16...0.27%. The kernel of sunflower seeds contains di and trisaccharides (0.39...0.73%) and polysaccharides (2.53...2.91%), the kernel of cotton seeds contains -2.53...2.72, respectively. % and 4.6...4.9%. During the processing of cotton seeds under high temperature conditions, ¬carbohydrates interact with protein substances to form intensely colored, water-insoluble melanoidin compounds. V.P. Rzhekhin experimentally established that when a powdered mixture of glucose and lysine is heated with an increase in temperature by 10 ^{0}C (within 105...130 ^{0}C), the rate of binding of sugars to amino acids is approximately twice as high. The process of combining carbohydrates with amino acids is undesirable because it loses sugars, lysine and other amino acids, and also deteriorates the color of the crude oil.

Sterols

The main component of the unsaponifiable substances of the oil are sterols. Sterols in free form and in the form of fatty acid esters are widely distributed in the cells of animal and plant tissues. In oilseeds, sterols are distributed in almost equal quantities in the oil and gel phases. When the oil is extracted, the sterols are transferred to the oil. Research by A.M. Goldovsky found that during extraction there is a more intense transition of sterols into the oil phase than during pressing. According to A. Kaufman, the content of sterols in raw cottonseed oil reaches 1.6%. When chromatography of black cottonseed oil in a column with aluminum oxide, A.U. Umarov isolated pure sitosterol in an amount of 0.47%. During alkaline refining of cottonseed oil, some of the sterols are carried away into soapstock, so that the refined oil contains no more than 0.11% sitosterol. The study of the composition and properties of the components included in the kernel of oil seeds and in raw oils showed that they undergo various changes during the processing of raw materials. Changes and interactions of the studied components of oilseed raw materials depend on the method of extracting vegetable ¬oil, consideration of which is also necessary when developing new and improving existing technological processes.

Technical and Economic Indicators for Sustainable Development

According to preliminary calculations, the average yield of raw cotton per hectare is 20 centners; from this amount, 666.6–733.3 kilograms of fiber and 1066.6–1200 kilograms of seeds can be produced. From 666.6 kilograms of fiber, more than 6.6 thousand meters of fabric are produced, and from 1066.6 kilograms of seeds - 207.0 kg of oil, 18.8 kg of soap, 439.2 kg of cake, 313.7 kg of husk, up to 6, 3 kg of lint ...” Based on the calculation, the average yield of raw cotton per hectare is 30 centners, 733.3 kilograms of fiber produces more than 7.3 thousand meters of fabric, and from 1200 kilograms of seeds - 232.9 kg of oil, 21.1 kg of soap, 494.1 kg cake, 352.9 kg of husk, up to 7.1 kg of lint .... Cotton waste – lint (1 ton), burnt. In parallel, 1 ton of this biomass is hydrolyzed with enzymes to produce glucose with a yield of 55%; the hydrolyzate is fermented and distilled with a yield of 90% to obtain ethanol.

Biofuel Productivity

When discussing the results obtained, it is important to understand which method of utilization of plant raw materials provides the greatest energy gain: direct combustion of biomass or combustion of liquid biofuel and solid waste from its production? To do this, it is advisable to analyze several typical examples of thermal energy production.

- Example 1: Fallen olives (1 ton per dry sample) containing 35% oil are burned.

In parallel, 1 ton of this biomass is pressed to a residual oil content of 10% with a residual yield of 90%, and then the pressed olive oil is used for combustion and thermal energy production.

- Example 2: Fallen olives (1 ton per dry sample) containing 35% oil are burned.

In parallel, 1 ton of this biomass is pressed to a residual oil content of 10% with a residual yield of 90%, and the pressed oil is subjected to transesterification with a yield of 90%; Biodiesel is then used for combustion to produce thermal energy.

- Example 3: Wood sawdust (1 ton) is burned. In parallel, 1 ton of this biomass is subjected to alkaline pretreatment (yield 70%) and hydrolyzed with enzymes to produce glucose with a yield of 50%, as described, for example, in [7]; the hydrolyzate is fermented and distilled in 90% yield to produce ethanol, which is burned.

- Example 4: Cotton is the main agricultural crop of Central Asia. A cotton boll is a veritable storehouse of the richest natural resources, each containing 2-10 grams of a universal product called raw cotton. Cotton depending on the variety, characteristics of sowing zones and other factors. The growing season lasts from 100 to 200 days, and the height of the main stem of plants reaches 50-120 cm. Each plant has 10-30 or more boxes (biter) the size of a walnut or slightly larger, they are spherical or ovoid in shape, with a spout and an asterisk. The fiber yield from each box is 20–40 percent, with a length of 25 to 42 mm, which is used for the production of yarn. Oil, which is widely used, is extracted from the seeds. The seeds, as well as the shell of the box, are raw materials from which literally anything can be made. For example, cake is a nutritious feed that promotes growth, improves fatness, productivity of livestock, improves the quality of meat and milk; down and down - they are used for the manufacture of artificial fiber, film, plastics; husk - raw material for the production of various synthetic materials, high-quality polymers that are not afraid of heat treatment, replacing metal in the manufacture of heating devices; Gossypol is extracted from cotton seeds , used to produce heat-resistant coatings, varnishes, dyes and medicines. Cellulose, linoleum, cardboard, and insulating materials are produced from waste from cotton gins and oil mills [8].

Some of the cotton and down are used to make cotton wool used in medicine, the light and furniture industries, as well as batting for the production of linings, filters and other technical products. Vitamin P, carotene, protein yeast, antibiotics, starch, rope, paper, cardboard, various acids, including 15 amino acids, resins, salts, more than 10 phenolic compounds, about 20 are produced from leaves, stems, leaves and bark. high-molecular carbohydrates, alcohols, waxes, etc., more than 100 different chemicals, and in total over a thousand types of products, products, goods, and medicines are produced from cotton [9].

- Example 5: Pure cellulose (1 ton) is burned. In parallel, 1 ton of this biomass is hydrolyzed with enzymes until 100% conversion of cellulose into glucose; The glucose hydrolyzate is fermented and distilled to produce absolute ethanol, which is burned. From the results obtained, it follows that in all of the above examples, the most energetically advantageous is the direct combustion of plant biomass, while the combustion of the amount of liquid biofuel that can be obtained from this biomass gives a significantly lower thermal effect.

Even in theoretical studies (example 5), with complete conversion of pure cellulose into glucose without residue and complete conversion of glucose into ethanol, the heat of combustion of the entire resulting amount of liquid biofuel (567 kg) was less (15.5 GJ) than when burning 1 ton of original cellulose (16.3 GJ). Thus, despite the fact that the specific heat of combustion of liquid biofuel was higher than that of the original biomass, the total amount of heat generated during its combustion was less due to the limited yield of biofuel when obtained from plant raw materials [10-14]. Even additional combustion of production residues cannot make up for the existing shortage of thermal energy.

Conclusion

From the scientific review, technical, economic and energy calculations of the use of cotton plant biomass the following results were obtained: The specific heat of combustion of liquid biofuels is higher than that of the original biomass samples. Despite this, direct combustion of plant biomass turned out to be the most energy-efficient, while combustion of the amount of liquid biofuel that can be obtained from plant raw materials produces a significantly lower thermal effect. The basis of cotton biomass is organic carbon compounds, which, when combined with oxygen during combustion or as a result of natural metabolism, ¬release heat. The net energy that can be obtained from combustion varies from 10 GJ/t (green wood) to 40 GJ/t (fats, petroleum-like substances) and 55 GJ/t for methane. The heat of combustion of absolutely dry biomass, consisting mainly of carbohydrates, is about 20 GJ/t.

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