The use of renewable sources for synthesis of cosmetics ingredients

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Introduction

Since the 1960s the interest in renewable resources has been growing. One of such resources is biomass, whose main components are mono-and polysaccharides making about 3/4 all the biomass produced on the Earth [1]. In general, the term renewable resources refer to three types of natural products: vegetable and animal fats, biomass and latex from rubber trees [1]. The strategy of use of renewable resources in Poland has been discussed in the "National Development Strategy for 2007÷2015" [2]. Although biomass and other renewable resources are used primarily for energy production, in recent years new directions of their practical applications have been developed. They can be used in many industrial branches, including pharmaceutical, chemical and cosmetic industries.

Renewable materials are very attractive for the production of chemical compounds, such as: oil from oilseeds, starch from cereals and potatoes, and cellulose from grasses and wood because of their widespread availability. By physical, chemical and biochemical methods, these materials may be converted to intermediates that are used to produce highly valuable chemicals, polymers, lubricants, solvents, surfactants and specialty products, which have been hitherto obtained from fossil fuels, e.g. from crude oil. Metzger and co-workers in 2004 [3] presented a cycle of biomass, showing the benefits of regeneration of renewable resources (Fig. 1).

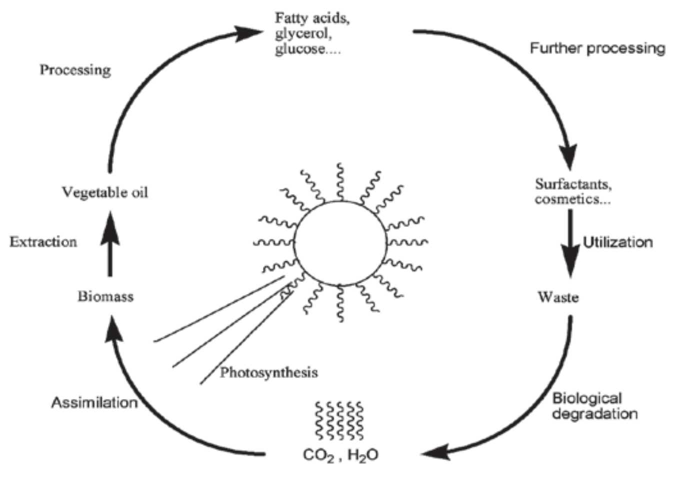

Fig.1. Cycle of biomass [3]

Through the process of photosynthesis, biomass is formed providing renewable raw materials such as vegetable oil, starch, etc. These products are processed into fatty acids, glycerol, glucose, etc. Subsequent processing of the above mentioned compounds can give surfactants and cosmetics. The natural products can be easily utilized. The resulting waste is biodegradable to carbon dioxide and water [3].

Below a brief characterisation of such renewable materials as vegetable oils, carbohydrates, terpenes and glycerol are given.

Vegetable oils

Generally, vegetable oils are any substances of oily consistency obtained from any plant. They can be derived from different parts of plants, such as a fruit, fruit stones, plant seedlings or seeds such as rapeseed oil and soybean oil. Vegetable oils are used as edible fats, cosmetic ingredients, and some of them as therapeutic agents (e.g. evening primrose oil). They can be also applied as raw materials for the manufacture of varnish paints and for impregnation (e.g. linseed oil). Increasingly important is the use of vegetable oils in the production of biofuels. Cold-pressed vegetable oils show the highest quality because refined oils loose some valuable properties, have hardly any smell or taste, however they resist high temperatures and they are much cheaper.

Vegetable oils (or fats) are mixtures of mono- and three-substituted esters of glycerol and higher fatty acids, usually containing 16, 18 or 20 carbon atoms. The fats extracted from plant material contain from a few to several fatty acids. Vegetable oils are usually subjected to chemical processing either through hydrolysis or transesterification. They can be used for the production of surfactants, lubricants, dicarboxylic acid, resins, stabilisers, plasticisers, secondary alcohols and polyols [4].

The majority of natural vegetable oils contain polyunsaturated fatty acids such as linoleic and linolenic acid. These acids are easily oxidized, which is manifested by unpleasant smell and decomposition. A solution to this problem is the search for plants which are rich in monounsaturated oleic acid, which ensures greater resistance to oxidation. The company Clariant working with sunflower oil has developed a product called Hostacerin®SFO, which is in more detail discussed below [5].

Carbohydrates

Carbohydrates are the most numerous natural organic compounds, mostly occurring as polymers. These compounds have been intensively studied as precursors to obtain fine chemicals [6].

Recently, much attention has been paid to heterogeneous oxidation of simple sugars, dehydration or hydrogenation [7÷9]. Polyhydroxy acids obtained by oxidation of fructose and glucose, have found wide application in many branches of industry, especially the AHA acids (α-hydroxy acids) used in the production of cosmetics. The fruit acids most popular and most commonly used in cosmetics industry are: glycolic, tartaric, lactic, malic and citric ones. These compounds exhibit skin whitening properties have the ability to relax the corneocytes layer of epidermal and facilitate its peeling [10]. In addition, there is a huge demand for such products of carbohydrates reduction as mannitol or sorbitol (Fig. 2).

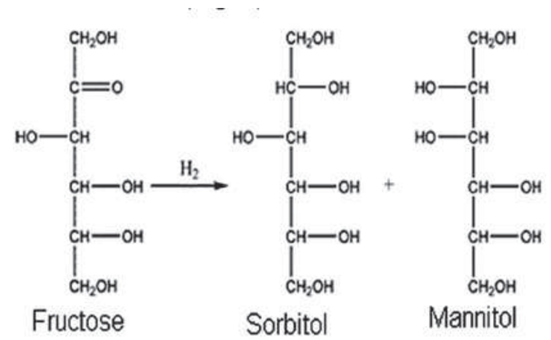

Fig. 2. Conversion of fructose to polyols

The products of this reaction are widely used in cosmetics and polyurethanes, for example, sorbitol is a cheap polyol used as softening and moisturizing stabilizer in cosmetic industry. This compound, combined with natural sunflower oil in the transesterification reaction allows obtaining a new emulsifying system, which is Hostacerin®SFO. Both substrates are 100% derived from renewable sources. In the manufacturing process these raw materials are completely consumed. This preparation is a mixture of esters of sorbitol, partial glycerides, which have emulsifying effect. In addition, it also contains residual triglycerides and sorbitol, showing moisturizing effect [5].

Terpenes

Terpenes are hydrocarbons of plant origin of the general formula $(C_5H_8)_n$. These compounds, which are renewable resources, are oligomers of isoprene. Their large selection (Fig. 3) as renewable sources makes them a valuable acquisition to product highly valuable products [11÷13]. They are substrates at the intermediate stages of preparation of fragrances, flavours, and vitamin E [14].

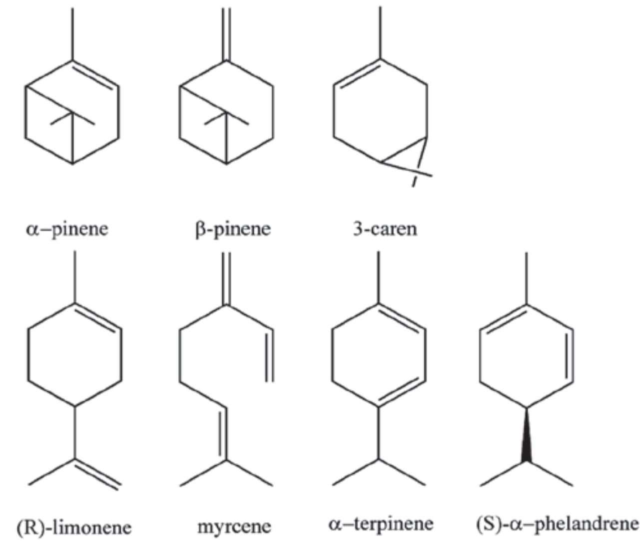

Fig. 3. Main structure of terpenes

The most commonly used terpenes/terpenoids are geraniol, α-pinene, limonene and citronellol. The first of them is commonly used in perfume production. It can be used in every the floral-rose compositions and in soaps which do not lose their colour. Geraniol is an important intermediate product in the production of geranyl esters, citronellol or citral.

α-pinene is also a starting substrate for many syntheses of industrial importance. From α-pinene it is possible to obtain such compounds as terpineol, menthol, as well as borneol/cytal derivatives such as geraniol, linalool, cytral and citranellol, citranellal. These chemicals are used in the manufacture of fragrances [11]. This terpene, α-pinene, is also the initial product in the synthesis of camphor, which has found application in fragrances, insecticides, plasticisers, preservatives. It is also used as a reagent for syntheses [12].

Glycerol

Glycerol (1,2,3-propanotriol, glycerine) is a colourless and odourless liquid with a sweet taste, derived from natural and petrochemical sources [15]. Glycerol is by-product in the production of biodiesel, for every 9 kg of biodiesel produced 1 kg of glycerol is obtained. As a consequence, increased production of glycerol and decrease in its price has made glycerol a promising substrate in many chemical processes, such as oxidation reactions, etherification, esterification [16÷22]. Currently there are about 1,500 known applications of glycerol. It can be used in the cosmetics industry (in toiletries, creams), in pharmaceutical formulations, in foodstuffs, in the tobacco industry, for the synthesis of TNT, alkyd resins and polyurethanes. Presently, the amount of glycerol, which is necessary for technical applications is around 160 000 tonnes. The use of glycerol by industry is shown in Figure 4.

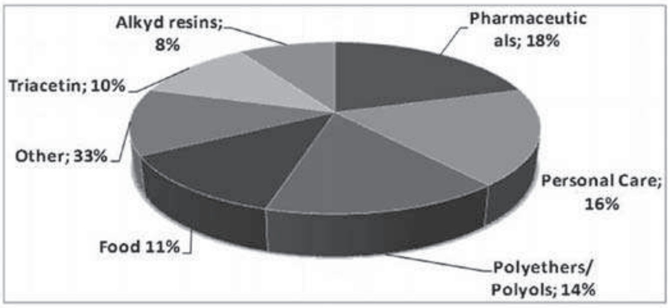

Fig. 4. The use of glycerol by industry [23]

Summary

Renewable resources, their use and modification in important process, have a major influence on our everyday lives. They can be applied in a variety of sectors, such as: energy sector, chemistry, pharmacy, textile industry and in an ever-growing cosmetic industry.

Translation into English by the Author

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International Symposium on Electronic/Optic Functional Molecules

11-13 March 2012, Shanghai, China

Official Information:

The international symposium aims to provide a forum for discussing innovative research and development in the research field of Electronic/Optic Functional Molecules and their applications, including organic electronics, organic optics, chemosensors, molecular machines and their bio-applications, and so on. An objective of the international symposium is to honor Prof. Klaus Müllen, one of the pioneers of the field of organic electronics and optic materials, on the occasion of his 65th birthday. The symposium will be held on Mar 11-13, 2012, in East China University of Science and Technology, Shanghai, China. The Chairman is Prof. He Tian. For more details about the symposium and registration, please visit the homepage of the symposium (http://hyxy.ecust.edu.cn/iseofm/).

Confirmed plenary lecturers (to be continued)

1) Prof. Takuzo Aida, University of Tokyo, Japan
2) Prof. Eric V. Anslyn, University of Texas at Austin, USA
3) Prof. Jean-Luc Brédas, Georgia Tech, USA
4) Prof. Alan Heeger, UCSB, USA, Nobel Prizer winner
5) Prof. Klaus Müllen, MPI, Mainz, Germany
6) Prof. Peter Stang, Univ. Utah, USA
7) Prof. Xi Zhang, Tsinghua University, China

Invited lecturers (more to come)

1) Harry L. Anderson, UK
2) Peter Bäuerle, Germany
3) Uwe H. F. Bunz, USA
4) Yves Henri Geerts, Belguim
5) Stefan Hecht, Gremany
6) Emil J. W. List, Austria
7) Seth Marder, USA
8) Soo Young Park, South Korea
9) Paolo Samori, France
10) Ullrich Scherf, Germany
11) Licheng Sun, Sweden
12) Mark D. Watson, USA
13) Jean Roncali, France
14) Thorri Gunnlaugsson,Ireland
15) Tomas Torres, Spain
16) Hiroyuki Furuta, Japan
17) Yuliang Li, China
18) Lixiang Wang, China
19) Steven J. Langford, Australia
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