

Production status, economic benefit and environmental impact of lanolin cholesterol

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Abstract. The main pollutants in wool washing wastewater are lanolin and surfactants, which are difficult and expensive to treat. Lanolin, as a natural raw material widely used in cosmetics, pharmaceuticals, leather, and other fine chemical fields, has great economic value. The chief aim of this paper is to summarize the development status and indirectly environmental impact of lanolin derivatives, compare the cholesterol content data of lanolin samples commonly used in the world through experimental means, and provide guidance and suggestions for the raw material selection of lanolin cholesterol production plants in the future. The method used in this study is known as nuclear magnetic resonance: the author tests and compares the cholesterol standard sample and other 3 different unprocessed lanolin samples. The research has recorded valuable data about the unprocessed lanolin from Ningxia, China contains the highest amount of cholesterol. Therefore, the result of this study provides feasible advice for the lanolin cholesterol production factories when selecting the production's raw material; also, the conclusive method of cleaning wool-washing waste water provides instructive idea for the factories that produce lanolin derivatives.

Keywords: lanolin cholesterol; production status; economic benefit; environmental impact.

1. Introduction

Lanolin is a fatty substance attached to wool. The process of washing wool produces a large amount of lanolin containing sewage also known as unprocessed lanolin. The main components of lanolin are fatty acid ester, hydroxyl acid ester, free sterol and polyhydroxyl residue, which account for 55.14%, 25.57%, 4.04% and 13.15% of the total weight of lanolin respectively. With the saponification of lanolin, lanolin alcohol and lanoic acid will form instantly. The main components of lanolin alcohol are cholesterol and lanosterin, the relative contents are 44.31% and 14.62%, respectively [1, 2]. Lanolin can be made into various lanolin derivatives by chemical reactions [3, 4]. China's wool resources are rich. Unprocessed lanolin production is high, but due to the complex composition of lanolin, the refining process is easy to emulsify while water washing is difficult, resulting in low yield, wastewater discharge and other problems. The current research on the recovery of unprocessed lanolin refining is less, limiting the application of lanolin, resulting in a waste of resources [5]. At the same time, the direct discharge causes serious pollution to the soil and the surrounding environment. Therefore, if the diversity and practicability of lanolin derivatives can be increased to make the unprocessed lanolin fully recycled, the pollution problem caused by wastewater discharge can be solved effectively.

In addition, via consulting lanolin-processing factories, the author finds out that the price of unprocessed lanolin is low, only 27,000 to 32,000 yuan per ton, but the value of lanolin derivatives is very high. For example, calcium lanolate can act as industrial rust inhibitor, isopropyl lanolate can be used as raw material in make-ups. The lanolin cholesterol contains the highest economic value among these lanolin derivatives, since it is the raw material of vitamin D3. The price of lanolin cholesterol depends on its purity and is generally 300,000 to 500,000 yuan per ton. Among lanolin produced in China, about 10 to 14 percent of the cholesterol is present, more than the cholesterol content in Australian lanolin and New Zealand lanolin. Therefore, in terms of lanolin cholesterol production, China's unprocessed lanolin has a higher economic value.

In summary, chemical reaction treatment of wool cleaning wastewater can produce a wealth of lanolin derivatives, which can be applied in many different fields. Among them, lanolin cholesterol

contains the most economic benefits, given its scarcity and the importance of subsequent applications. Therefore, the development of lanolin cholesterol products can effectively improve the utilization rate of unprocessed lanolin, and reduce the environmental pollution impact caused by the discharge of wool cleaning wastewater.

Lanolin has a wide range of extended products in many fields, which are uniformly called lanolin derivatives in this essay, such as: lanolin cholesterol, calcium lanate rust inhibitor, lanolin alcohol and other products. Among them, the most valuable is lanolin cholesterol. In biomedicine, cholesterol is used as a raw material in the production of vitamin D3. According to the research and development achievements report of the largest vitamin D3 production company in China, the industrialization of lanolin cholesterol solves the problem that the cholesterol raw materials required for domestic vitamin D3 products must be imported. Furthermore, the application of cholesterol in cosmetics and surfactants cholesterol can be used as a multi-functional cosmetic additive with biological activity, and the United States CTFA cosmetic raw materials manual has listed cholesterol as a natural active substance that can be added to cosmetics. This kind of substance has a smooth and moisturizing effect, no irritation to the skin, nor photosensitization, for dry and rough skin is an excellent lubricant [3]. Moreover, cholesterol in cosmetics and surfactants application cholesterol can be used as a bioactive multi-functional cosmetic additive, the United States CTFA cosmetic ingredients manual has listed cholesterol as a natural active substance that can be added to cosmetics. This kind of substance has a smooth and moisturizing effect, no irritation to the skin, nor photosensitization, for dry and rough skin is an excellent lubricant [6].

Cholesterol is usually derived from two sources: First, from animal brain stem. Second, from lanolin. However, animal brain stem may carry mad cow disease virus, so Europe and the United States have long banned the process of extracting cholesterol from animal brain stem, and the source of vitamin D3 production raw material cholesterol is clearly stipulated as lanolin. In addition, China has also promulgated a new national standard related to cholesterol in 2021: China's new national standard GB 7300 202-2019 also stipulates lanolin cholesterol as the only legal source of raw material to produce VD3 [7]. The production of lanolin cholesterol promotes the high-value utilization of lanolin and improves the vitamin D3 industry chain.

The main producers of lanolin in the world are Australia, New Zealand and China, accounting for 35%, 20% and 13% of the output respectively. Lanolin cholesterol, as a raw material of vitamin D3, has received worldwide attention. At present, the worldwide companies that produce lanolin cholesterol are mainly: China's Zhejiang Garden biological, Japan refined, Singapore Enkai and India Dixman. China's Zhejiang Garden Biological is the world's largest lanolin cholesterol producer, whose expansion plan will increase the annual capacity to 1,200 tons. The company has NF cholesterol production process, which share of more than 50% in the global and Chinese market. At the same time, there are many by-products in the production process of lanolin cholesterol, and the byproduct output is proportional to the output of lanolin cholesterol.

The aim of this paper is to summarize the development status and beneficial environmental impact of lanolin derivatives, compare the cholesterol content data of lanolin samples commonly used in the world through experimental means, and provide guidance and suggestions for the raw material selection of lanolin cholesterol production plants in the future.

2. Method

2.1. Sample source

The author used 99% purity cholesterol in the market as the standard value, and selected three samples provided by Shanghai FansLubrication Technology Co., LTD., which were produced in Australia, New Zealand and China respectively, to investigate the NMR hydrogen spectrum of different lanolin materials for data analysis.

2.2. Determination of cholesterol content

The cholesterol content of lanolin from different producing areas was determined by nuclear magnetic resonance (NMR). The author used 99% purity cholesterol in the market as the standard value, and selected three samples provided by Shanghai FansLubrication Technology Co., LTD., which were produced in Australia, New Zealand and China respectively, to investigate the NMR hydrogen spectrum of different lanolin materials for data analysis.

3. Results and discussion

3.1. Analysis of NMR

The results of NMR experiments are compared as shown in fig.1. It is found that in the cholesterol standard sample, the values of chemical shift are 2.0, 4.0, 5.5 and 7.0, which indicate there might contain alkane group, alcohol group, alkene group, and aromatic hydrocarbon. The values below these peaks are the differential result, which refer to the number of hydrogen atom. In conclusion, the surrounding of alkane groups exists approximately 8 hydrogen atoms, the alcohol group connects with 1 hydrogen atom, the alkene group contains 1 hydrogen atom, and the peak of aromatic group might be an impurity, as the author could not calculate its area.

Admittedly, these three samples all contain cholesterol. However, with several data of the cholesterol standard sample, the author finds that the values on the spectrum of lanolin from Ningxia, China are closer to the values of cholesterol standard sample: the values of chemical shift are 2.0, 3.5, 5.5, so the functional groups are like the arrangement of cholesterol standard sample. Also, the area of the peak is similar too: there are 10 hydrogen atoms beside alkane groups, 1 or 0 hydrogen atom near alcohol group, and 1 hydrogen atom in alkene group. In summary, the nuclear magnetic resonance peak of cholesterol in lanolin of Ningxia, China, was the closest to the peak of cholesterol standard sample: the chemical shift value was the closest to the cholesterol standard sample, and the coupling splitting was the closest to the coupling constant. Therefore, lanolin from Ningxia, China, contains cholesterol, and the cholesterol content is the closest to the cholesterol standard.

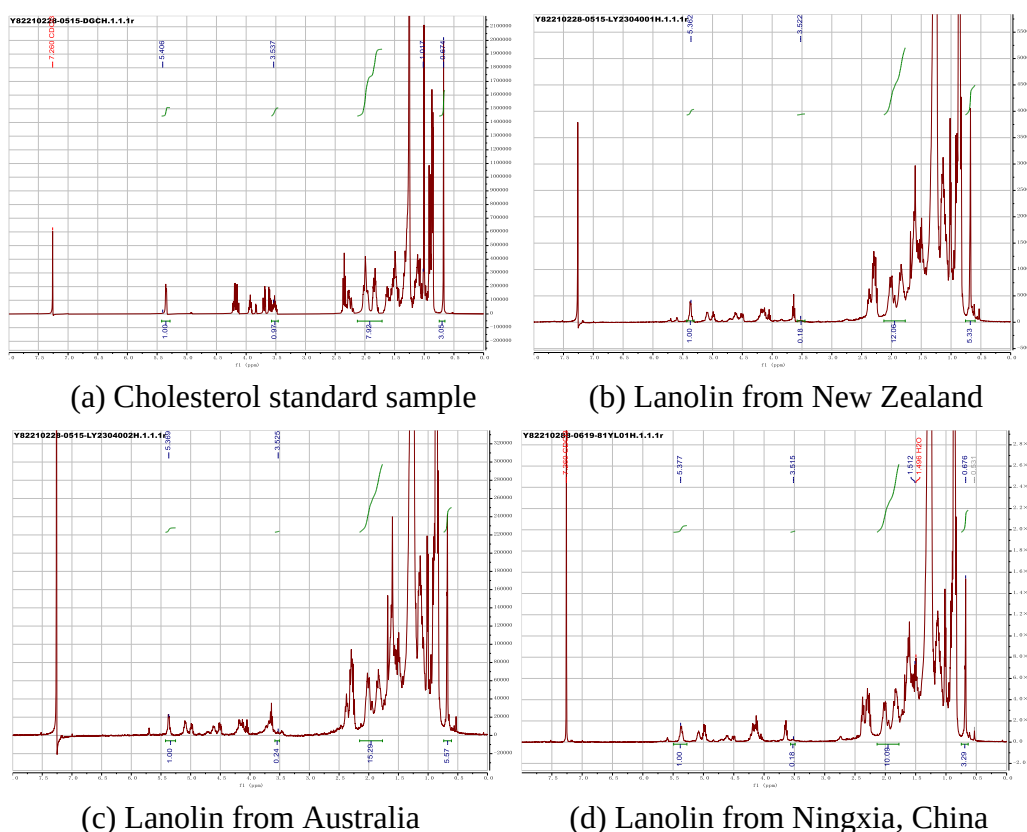


Fig 1. NMR results of different samples

3.2. Production limitations of lanolin cholesterol

The production process of lanolin cholesterol is very complex. It is necessary to complete the transesterification process of lanolin to produce methyl lanate and free the unprocessed lanolin alcohol containing cholesterol. Then the reaction mixture is separated to get the cholesterol-rich lanolin alcohol fraction; Then the cholesterol-rich lanolin alcohol fraction was complexed to separate the cholesterol from other lanolin alcohol, and then further purified by counter-current crystallization to obtain NF grade cholesterol product, and complex cholesterol product containing 24-dehydrocholesterol was produced by side. Finally, other by-products were processed to obtain lanolin derivatives such as lanolin fatty acid and cosmetics grade lanolin alcohol. Therefore, lanolin cholesterol is a huge investment because of the complexity of the production process and processing equipment [8].

3.3. Analysis of environmental impact during lanolin cholesterol production

After visiting Zhejiang Garden lanolin cholesterol production factory, the author summarized the following environmental impact analysis of the process: 1) The use of lanolin to produce cholesterol, lanolin alcohol, lanolin fatty acid and other products in the production process of lanolin cholesterol, which belongs to the encouraged category (safety food additives, feed additives) projects, not restricted and eliminated industries; 2) In the process of producing lanolin cholesterol, there is no need to set atmospheric environmental protection distance, because the concentration of atmospheric pollutants does not exceed the standard value, and has no adverse impact on human health and ecological environment; 3) Clean production is implemented in the production process, and the method of combining source control and end treatment is adopted. According to the analysis and prediction results, after the net treatment of waste gas and noise in the production process, it can achieve the standard discharge, and will not cause the degradation of environmental quality functions. After the wastewater is treated to meet the standard, it is put into management, and after the wastewater treatment plant is treated to meet the standard, it will not have a direct impact on the surrounding surface water environment and groundwater environment [9].

3.4. Derivatives of Lanolin Cholesterol

Despite the production of lanolin cholesterol, this company also deeply researches and develops the production of vitamin D3 and its derivatives, such as: Food additive Compound nutrition fortification agent SDS (Vitamin D3 powder), Feed additive Vitamin D3 particles, Feed additive Vitamin D3 oil and so on [10]. These are all crucial additives in people's life.

4. Conclusion

The unprocessed lanolin is mainly produced from the wool-washing waste water, then this purified water was utilized as a dyeing and post-treatment medium for dyeing wool reactive colors. Wastewater from polyester strip dyeing and wool dyeing were combined at a volume ratio of about 2:1. The water was then cleaned using deep mineralization technology. This not only enables the effective utilization of unprocessed lanolin, but also does not lead to environmental contamination. If the waste water containing lanolin produced by wool washing industry is not recycled, not only a lot of beneficial substances are lost, but also soil and water resources are polluted. But after a variety of chemical reactions made of lanolin derivatives have a high economic value, which is a process of turning waste into treasure, especially lanolin cholesterol is the key raw material of vitamin D3, and vitamin D3 is not only beneficial to the human body, but also it used in feed additives and it can improve the growth rate and immune ability of animals. Therefore, the development and utilization of lanolin derivatives has improved the economic value of lanolin. Lanolin is cheap and rich in sources, which contains rich and valuable cholesterol. At the same time, because the risk of extracting

cholesterol from brain stem such as mad cow disease, lanolin cholesterol has a very good development prospect. As a raw material of vitamin D3, with the increasing market demand, the production technology and product quality of enterprises continue to improve, the amount of lanolin cholesterol in the world will have greater growth in the future.

References

- [1] Wang Beibei, Chen Jingnan, Yu Yuanda, et al. Analysis of physicochemical indexes and main components of lanolin. *Chinese grease*, 2022, (01): 22-27.
- [2] Wang Xiaohan, Hua Lei, Gao Liang, et al. Progress in extraction and enrichment of branched-chain fatty acids from lanolin. *China Oils and Fats*, 2021, 46(5):33-39.
- [3] Liu Jiangang, Wang Ziqiang. Advances in New Chiral Crown Ethers and Looking to Synthesize a New Class of Chiral Crown Ethers. *Zhejiang Chemical Industry*, 2015, 46(9):26-29.
- [4] Wang Beibei. The physical and chemical properties analysis of lanolin and refined technology research. *Henan university of technology*, 2023.
- [5] Liu Guoxiu. Study on the Lanolin Advanced Recycling Technology of Wool Scouring Effluent. *Donghua University*, 2015.
- [6] Zhou Yu. Study on supercritical CO₂ extraction of pengbo semi-fine sheep lanolin. *China Leather*, 2019, 48(8):35-41.
- [7] Chinese National standard GB 7300 202-2019 Feed additives-Part 2: Vitamins and retinoids Vitamin D3. 2019.
- [8] Liu Guoxiu, Yu Yicheng, Tang Di, et al. A Comparative Study of Lanolin in the Wool Washing Wastewater. *Environmental Engineering*, 2015, 33:648-652.
- [9] Biochemicals. Vitamin D3 series Products. Retrieved on July 25th, 2024, retrieved from <http://en.hybiotech.com/blank02.html>.
- [10] Li Ruifeng, Wei Fangni, Xu Chengshu, et al. Advanced treatment and reuse of wool and polyester dyeing wastewater. *Printing and Dyeing*, 2024, (05): 61-63.