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Extraction and Purification Process of Lanolin from Sheep Wool and Industrial Washing Effluents

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Abstract

Lanolin is a natural, complex wax produced by the sebaceous glands of wool-bearing sheep. It is widely utilized across the pharmaceutical, cosmetic, and industrial sectors due to its exceptional emollient, moisturizing, and protective properties. This study focuses on the extraction, purification, and characterization of lanolin derived from Algerian sheep wool. Extraction was performed using two distinct methods: a scouring and centrifugation technique as the primary approach, and a Soxhlet solvent extraction method using chloroform as a comparative reference, yielding 5.0% and 14.0% of crude lanolin, respectively. The subsequent purification of the crude product was carried out through a comprehensive four-stage process, involving acidification with phosphoric acid, neutralization with sodium hydroxide, washing with sodium chloride and hydro-alcoholic solutions, and a final drying step at 105°C. The purified lanolin was characterized based on its color, aspect, solubility, melting point, acid value, and saponification value. The physicochemical analysis revealed a melting point of 39°C, an acid value of 0.87 mg KOH/g, and a saponification value of 102.6 mg KOH/g. These results perfectly comply with the standard requirements established by the British Pharmacopoeia (BP 2023) for pharmaceutical-grade lanolin. Consequently, these findings clearly demonstrate that Algerian sheep wool represents a viable and high-quality source for pharmaceutical lanolin extraction, offering significant potential for industrial and agricultural exploitation in Algeria.

Keywords: Lanolin, wool wax, sebaceous glands, Algerian sheep, Ovis aries, scouring, centrifugation.

ملخص

يُعدّ اللانولين شمعاً طبيعياً معقداً تفرزه الغدد الدهنية للأغنام المنتجِة للصوف. ويُستخدم على نطاق واسع في المجالات الصيدلانية، التجميلية، والصناعية بفضل خصائصه المطرية، المرطبة، والواقية الاستثنائية. تركز هذه الدراسة على استخلاص وتنقية وتوصيف اللانولين المستخلص من صوف الأغنام الجزائرية. تم إجراء الاستخلاص باستخدام تقنيتين مختلفتين: طريقة الغسل والطرد المركزي كتقنية أساسية، وطريقة الاستخلاص بالمذيبات باستخدام جهاز سوكسله والكلوروفورم كمرجع للمقارنة، حيث بلغت نسبة المردود 5.0% و 14.0% من اللانولين الخام على التوالي. بعد ذلك، خضع المنتج الخام لعملية تنقية شاملة تضمنت أربع مراحل: التحميض بحمض الفوسفوريك، التعادل بهيدروكسيد الصوديوم، الغسل بمحلول كلوريد الصوديوم والمحاليل المائية الكحولية، وأخيراً التجفيف عند 105 درجة مئوية. تم توصيف اللانولين المنقى بالاعتماد على اللون، المظهر، الذوبان، نقطة الانصهار، مؤشر الحموضة (Acid value)، ومؤشر التصبن .(Saponification value) وأظهر التحليل الفيزيائي والكيميائي أن نقطة الانصهار بلغت 39 درجة مئوية، ومؤشر الحموضة 0.87 ملغ/KOH غ، ومؤشر التصبن 102.6 ملغ/KOH غ. تتوافق هذه القيم التي تم الحصول عليها تماماً مع المعايير القياسية المعتمدة في دستور الأدوية البريطاني (BP 2023)الخاص باللانولين من الدرجة الصيدلانية. وبناءً على ذلك، تُثبت هذه النتائج بوضوح أن صوف الأغنام الجزائرية يمثل مصدراً حيوياً وعالي الجودة لاستخلاص اللانولين الصيدلاني، مما يفتح آفاقاً واعدة للاستثمار الصناعي والفلاحي في الجزائر.

كلمات مفتاحية : لانولين، شمع الصوف، الغدد الدهنية، الأغنام الجزائرية، Ovis aries، الغسيل، الطرد المركزي.

Résumé

La lanoline est une cire complexe naturelle, produite par les glandes sébacées des moutons à laine. Elle est largement utilisée dans les secteurs pharmaceutique, cosmétique et industriel en raison de ses propriétés émollientes, hydratantes et protectrices exceptionnelles. Cette étude porte sur l'extraction, la purification et la caractérisation de la lanoline dérivée de la laine de mouton algérien. L'extraction a été réalisée selon deux méthodes distinctes : une technique de suintement (scouring) et de centrifugation comme approche principale, et une méthode d'extraction par solvant au Soxhlet utilisant le chloroforme comme référence comparative, donnant un rendement respectif de 5,0 % et 14,0 % de lanoline brute. La purification ultérieure du produit brut a été effectuée via un processus complet en quatre étapes, comprenant une acidification à l'acide phosphorique, une neutralisation à l'hydroxyde de sodium, un lavage avec une solution de chlorure de sodium et des solutions hydro-alcooliques, et enfin un séchage à 105°C. La lanoline purifiée a été caractérisée selon sa couleur, son aspect, sa solubilité, son point de fusion, son indice d'acide et son indice de saponification. L'analyse physico-chimique a révélé un point de fusion de 39°C, un indice d'acide de 0,87 mg KOH/g et un indice de saponification de 102,6 mg KOH/g. Ces résultats sont parfaitement conformes aux exigences standard établies par la Pharmacopée Britannique (BP 2023) pour la lanoline de qualité pharmaceutique. Par conséquent, ces résultats démontrent clairement que la laine de mouton algérien représente une source viable et de haute qualité pour l'extraction de lanoline pharmaceutique, offrant un potentiel important pour l'exploitation industrielle et agricole en Algérie.

Mots clés : Lanoline, cire de laine, glandes sébacées, mouton algérien, Ovis aries, lavage, centrifugation.

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Introduction

Algeria has one of the largest populations of sheep in North Africa which is over 30 million animals; sheep have been known for centuries as the agricultural backbone of the national economy of Algeria and represent a principal source of meat, milk and wool for rural areas. Despite the huge number of livestock resource the valorization of sheep by-products are very low; the wool is still largely unused except in carpet weaving and artisan trades. One of the valuable substances produced by sheep wool is lanolin, a complex natural wax which is produced and secreted by sebaceous glands in skin of wool-bearing sheep. This substance is one of the promising natural bioresources that are completely undeveloped in Algerian agriculture.

The lanolin (or wool wax or wool grease) is a highly complex mixture of esters, diesters and hydroxy-esters of fatty acids of high molecular weight and alcohols produced by sebaceous glands which are located in the dermis of sheep skin. Since the dawn of civilization, it is used for its amazing emollient and moisturizing properties and during the past century it has become one of the widely incorporated excipients used in pharmaceutical, cosmetics and dermatological formulations. Lanolin presents excellent properties, close structural similarity to human skin lipids, highly efficient water absorption and it melts near the normal physiological temperature of human skin which makes it indispensable as part of ointments, pharmaceutical preparations, and skin products.

From the biochemical point of view the extraction of lanolin and its characterization form a broad area of study involving animal biochemistry, chemistry of lipids and pharmacy. The process of extraction of lanolin from the raw wool implies several physicochemical operations that demand the knowledge of chemical composition and physical behavior of wool grease fraction like emulsion, mechanical separation and purification. The physicochemical characterization of lanolin after extraction based on international pharmacopeial standards is needed to prove the quality, purity and its potential applications in pharmaceutical and cosmetic products.

The wool fiber of Algerian native sheep breeds has coarse to medium fiber diameters and is mainly traded without any pretreatment or with basic washing during which wool grease is discharged to waste water without any recovery. This makes a huge waste and the unvalued natural bioresources of great pharmaceutical and economic importance.

The current work was carried out at the Laboratory of the Faculty of Natural and Life Sciences, Ferhat Abbas University Setif-1 aiming to bridge this gap and to study the extraction of lanolin from the Algerian sheep wool using the scouring and centrifugation method and to compare it with Soxhlet method (solvent extraction).

The current study is organized as follows: Chapter 1 presents bibliographic study on taxonomy and biology of sheep, sebaceous gland structure and function, production of suintine and lanolin. Chapter 2 deals with the lanolin in detail, it covers chemical composition, physico-chemical properties, extraction, applications in different fields, state of the valorization of lanolin in Algeria. Chapter 3 presents materials and methods used during the experimental work and Chapter 4 discusses and presents results. The study is ended by a conclusion and perspectives.