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Review

Recent progress in cleaner preservation of hides and skins

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ABSTRACT

The hides and skins are flayed from animals and further processed into leathers. As the main constituent of hides and skins is protein, these materials are highly susceptible to bacterial action. Therefore, adequate preservation of hides and skins is crucial in slaughterhouses and tanneries. Preservation using sodium chloride (SC) remains the most popular curing technique worldwide due to its ease, cost-effectiveness and the quality of the finished leather produced. The use of SC (approximately 40–50% on raw hides/skins weight) enhances the pollution load of tannery effluent, however, which becomes highly contaminated with increased total dissolved solids (TDS) and chlorides. To overcome this hurdle, researchers are constantly searching for alternative preservation techniques which are either totally void of SC or use only a small amount of SC. Based on the literature published mainly in the past decade, this review systematically and comprehensively summarizes current status and development trend about the cleaner preservation methods used in curing and soaking processes in leather industry. The discussed sodium chloride less curing methods contain SC + EDTA, SC + silica gel, SC + sodium meta-bisulphite and SC + boric acid, while the illustrated alternatives used in sodium chloride free curing methods include inorganic preservatives (potassium chloride, sodium sulfate, silicate and ozone), organic preservatives (natural and synthetic preservatives) and other chemical antiseptics. Emphasis is put on natural preservatives (paste plant formulations, essential oils, chlorophyll and bacteriocins), polyethylene glycol, ozone and physical preservative methods containing electric current, chilling and vacuum. Furthermore, several proposals are addressed for the development of eco-friendly and efficient preservation methods for hides and skins.

Contents

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1. Introduction

Hides and skins, the most valuable byproduct of meat industry, are normally converted into leathers. Leather-making industry is an age-old industry that has been serving the society as an important consumer industry. It provides the unique raw materials used to manufacture a wide range of consumer goods such as garments, shoes, bags and so on. However, tannery industry has been categorized as one of the highly polluting industries due to its adverse influence on the environment (Kanagaraj and Babu, 2002, Kanagaraj et al., 2015; Dixit et al., 2015). Using the sodium chloride (SC) cured hides and skins as the manufactured object, leather-processing typically involves a variety of processing steps that can be divided into four stages (Covington, 2011). The first stage is called preparation process that contains mainly soaking, degreasing, dehairing, liming, deliming and bating, and its fundamental purpose is to remove the unnecessary substances such as dirt, hair, grease and nonstructural proteins, and to open up collagenous fibers. The second stage is tanning process in which hides and skins are subjected to acid treatment (pickling), and then tanned by using metal salts (chromium (III) salt, for example) or vegetable tannins. The tanned hides and skins are named as leathers which are fundamentally different from their original materials. The third stage is also carried out in water environment where the dyeing, retanning and fatliquoring are often conducted to give leather colors, softness and some special properties. Finally, the leather is finished on the surface and mechanically treated to endow it with fashionable appearance and style. As shown in Fig. 1, various chemicals that are used during these processes are not fully absorbed by leathers leaving huge amount of pollution load through effluent streams. It is approximated that over 600 kg of waste is generated and 30–35 m^3 of water is used for every ton of wet-salted hide, which results in 200–300 kg of leather (Ozgunay et al., 2007).

Especially, salt used mainly in the curing of hides and skins, soaking, pickling and chrome tanning operations generates huge amounts of pollution in terms of total dissolved solids (TDS) and chlorides in the resulting effluent during leather-making process. Thereinto, the SC-curing accounts for about 40% of chlorides and 55% of TDS, respectively, in the entire leather-processing operations (Yu, 1999; Peng et al., 2014). Unfortunately, there is still no efficient and cost-effective technology available for treatment of the effluent containing such high concentration of neutral salt. To date, the SC-based curing method has been still occupying the dominant position in the preservation of hides and skins although the need for an alternative, 'eco-acceptable' curing system is widely recognized. Preservation of skins and hides by SC is based on the application of SC at a concentration of 40–50%, and its dual functions, namely dehydrating ability and bacteriostatic effect, are used profitably in this method (Bailey, 2003). The low-cost and low-tech properties are possibly the main reasons that this method is widely applied in the long-term preservation of hides and skins. Even so, many weaknesses have been noticed in the SC-curing (Bailey, 2003). For example, the destructive role of bacteria (Cadirci et al., 2010; Berber and Birbir, 2010; Aslan and Birbir, 2011b, 2012; Lama et al., 2012, 2013; Ulusoy and Birbir, 2015), especially halophilic bacteria (Bailey and Birbir, 1996; Shede et al., 2008; Berber et al., 2010c; Bilgi et al., 2015; Akpolat et al., 2015; Caglayan et al., 2015) has become more realistically appraised in the hide curing and storage process. Halophilic bacteria contain special lipases and proteases that can potentially digest substances in SC-cured hides, and it can result in the "red heat", one of the most common disadvantages of raw hides and skins (Akpolat et al., 2015). The red color associated with these organisms is due to a pigment produced by these bacteria. When this red coloration is found on SC-cured hides, it clearly shows that these organisms are present on the hides and skins. Another serious problem related to hide quality and curing is caused by a delay in cure that allows sufficient growth of microorganisms on the hide to damage the grain (Bailey, 2003; Aslan and Birbir, 2011a). No matter how well a hide is cured by SC, damage occurring before cure cannot be fixed, which is more common in hides that have to be collected from small abattoirs and taken to a central curing facility. Other problem of SC curing is transportation difficulties, and of course, the most serious and disputed issue is the negative impact on the environment as it burdens the environment with large amounts of the TDS and chlorides. The electrolytes discharged by the use of SC by the tanning industry led to the aggravation on the quality of soil and ground water, and this phenomenon get worse now more than ever before.

For these reasons, a close attention has been paid to SC curing itself in order to decrease the amount of SC used by the technology optimization and modification (Aslan and Birbir, 2011a; Eduard et al., 2008; Vijayalakshmi et al., 2009b; Barinova et al., 2009; Balada et al., 2009) as it is still the most widespread method of long-term raw hide preservation, and eco-friendly alternatives of SC curing have been intensively investigated simultaneously. Since the late 1970s, a number of alternative methods to conventional SC-curing have been investigated or adopted by industry to varying degrees in order to reduce the dependence on SC. Based mainly on the past decade literature, this review will provide comprehensive progress on the SC-less and SC-free preservation methods and emphasis will be put on the natural plant preservatives, chemical substances with antimicrobial and non-polluting properties, and advanced physical preservative technologies for the purpose of long and short-term preservation for hides and skins.

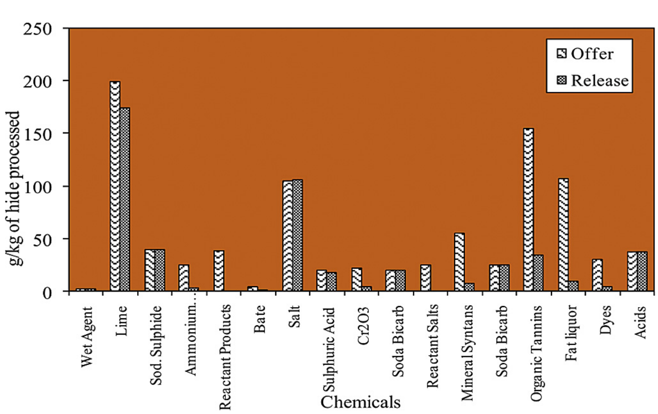

Fig. 1. Representative chemicals used in leather processing operations (Kanagaraj et al., 2015).