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Production, Characterization and Application of NILEST-Bate on Red Goat Skin for Leather Processing

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Abstract

In conventional leather processing technologies, bating process is based on the use of proteases in alkaline medium in order to break down the non-structural proteins of skin/hide, such as albumin, globulin substances that will eventually facilitate the splitting up of collagen fibres, so as to help in the penetration of tanning materials, thereby giving the finished leather the desired feel, softness, elasticity and other characteristic properties. NILEST-Bate is a natural product formed from blends of pancreatic and fungal enzymes. When compared to the commercial bate, it produced a finer grain leather with greater elasticity of goat skin. Physical testing analysis of the processed finished leather after the use of NILEST-Bate for bating showed about <37% and <12% increases in tensile and tear strengths, compared with the commercial bated leather. Results for shrinkage temperature were 80 and 82°C for NILEST-Bate and the commercial bate respectively. The results however, showed a decrease in percentage elongation (10%) in NILEST-Bate compared with the commercial product. Therefore, based on the results obtained in the present research, it can be concluded that NILEST-Bate can be used as a substitute for the available commercial bate (*Oropon*) used in leather manufacturing industries for bating process.

Keywords: Enzymes, Goat Skin, NILEST-Bate, Pancreatic Bate.

Introduction

Bate powder is one of the important products used in modern leather industries at pre-tanning stage for manufacturing of all types of characteristic grain and soft leathers of superior quality. Essentially, bating is a process that remove the protein substance that serves as the major structural component [1] in hides and skins to open up their fibre structures in order to facilitate the penetration of tanning materials. Enzymes

have been used in the leather industry to substitute the conventional process of bating [2]. The pancreatic enzymes of cattle, pig, goat, sheep and microbial enzymes of selected molds are widely used for the manufacture of bates [3].

NILEST-Bate is a natural product developed through research by the Directorate of Research and Development, Nigerian Institute of Leather and Science Technology, Samaru Zaria using largely locally available raw materials. The product has been tested using red goat skin and the quality was found to be comparable with imported commercial one 'Oropon'. At present the commercial tanneries in Nigeria import almost all the bate powder they need and the foreign exchange involved annually in importing is really large. It is envisaged that the production of this product and subsequent commercialization would go a long way in not only conserving some foreign exchanges for Nigeria but also alleviate the problem of acute shortage often faced by some leather industries in the country, making it self-reliant in bate powder production.

Materials and Methods

Materials

Bovine pancreas, *Aspergillus oryzae* and *Aspergillus parasiticus*, rice bran, cassava flour, lactic acid, ammonium chloride, ammonium sulphate and sodium chloride, raw goat skin.

Method

NILEST Bate Production involves blending of *Aspergillus oryzae* and *Aspergillus parasiticus* cultures with animal pancreas such as Bovine pancreas. The cultures of the molds used were grown according to the method described by Zekeya *et al.* [4]. The two species of molds were cultured on basal medium consisting of rice bran, cassava flour, lactic acid and selected metallic salts $Cacl_2$, Mgcl, Nacl. The basal medium was sterilized by autoclaving and used for culturing the molds and incubated for five days at room temperature.

The Animal Pancreas was then activated. The activation was carried out according to the method described by Zhang *et al*. [5] with little modifications. Briefly, fresh animal pancreas was minced using mortar and pestle into paste. Dilute sulphuric acid in a suitable quantity (20 mL) was added to the paste which caused the activation. Three different acid concentrations (10%, 20% and 40%) were used to activate three separate pancreases for the blending, which eventually gave rise to three NILEST-Bate products (A, B and C) with different pH values.

The activated pancreases (100 g) were separately blended with 20 g each cultures of *Aspergillus oryzae* and *Aspergillus parasiticus.* Specific amount (2.0g each) of ammonium chloride, ammonium sulphate and sodium chloride were then added. The blends were dried using oven

dryer at temperature of 45ºC until a constant weight was obtained, which was crushed to powder using mortar and pestle. The final product obtained was the NILEST Bate powder. The three products were then tested for enzymatic activity and the one with best activity was used for bating process and a commercially available bate powder was used as control for the leather production.

The NILEST-Bate products and commercial bate were then applied on a goat skin. A fresh red goat skin was purchased from abattoir and brought to Tannery unit in NILEST for processing to pelt stage before the application of the bate powder. Delimed goat pelt which had been soaked and dehaired by the lime-sulphide process was used for the bating trials. The pelts were cut into piece and kept in deliming liquor in a separate bottle and shaked in a mechanical swinging shaker at 10 rpm for 30 minutes. The bating trials used 900 and 1800 PU of NILEST-Bate or commercial bate both at pH 8.5, for different times (60-90 Mins). All experiments were performed in triplicate.

Thereafter the evaluation of bating efficacy on the finally prepared leather was carried out. After different bating trials with the NILEST-Bate products and with the commercial bate as control, the goat pelts were processed to prepared leather. The leathers produced were cut into pieces either perpendicular or parallel to the back bone orientation, and pieces were tested for tensile strength, tear strength, percentage elongation at break and bursting strength. Tensile strength was measured with a tensile machine model LR – C008 (DONGGUANLONROY Equipment Co.) with a uniform speed of separation of the jaws (100 ± 20 mm min^{-1}). A section around the central 50 mm portion of a piece of leather (110 mm long), 10 mm from the centre, 25 mm from the outer margins, was tested.

The average thickness of the piece was determined with Test Equipment (Wallace S4/9 London) and the load at break noted giving the tensile strength (kg cm^{-2}). Percentage elongation at break was measured on the tensile machine using a similar sized sample. The jaws of the machine were set 50 mm apart and the percentage elongation at break measured [(difference in length of sample/original length) x (100)]. The tear strength of the leather (50 x 25 mm of measured thickness) with a 20 mm long cut in the centre was assessed by running the tensile machine until the leather tore apart.

Results and Discussion

The results for enzymatic activity of the different NILEST-Bate powder at different pH values were presented in Fig.1. The result shows that product B with pH value 8.5 indicated the highest enzymatic activity than even the commercial (control) product at pH 8.3. NILEST-Bate Product B was then selected to test for its bating ability, which was compared with the commercial one. Two separate trials using 900 and 1800 PU

were carried out on each bate. The most important difference between the two types of bate was that the NILEST-Bate produced a finer texture to grain compared with commercial bate treatment, an indication that the NILEST-Bate produced more activity than the commercial bate with respect to grain texture.

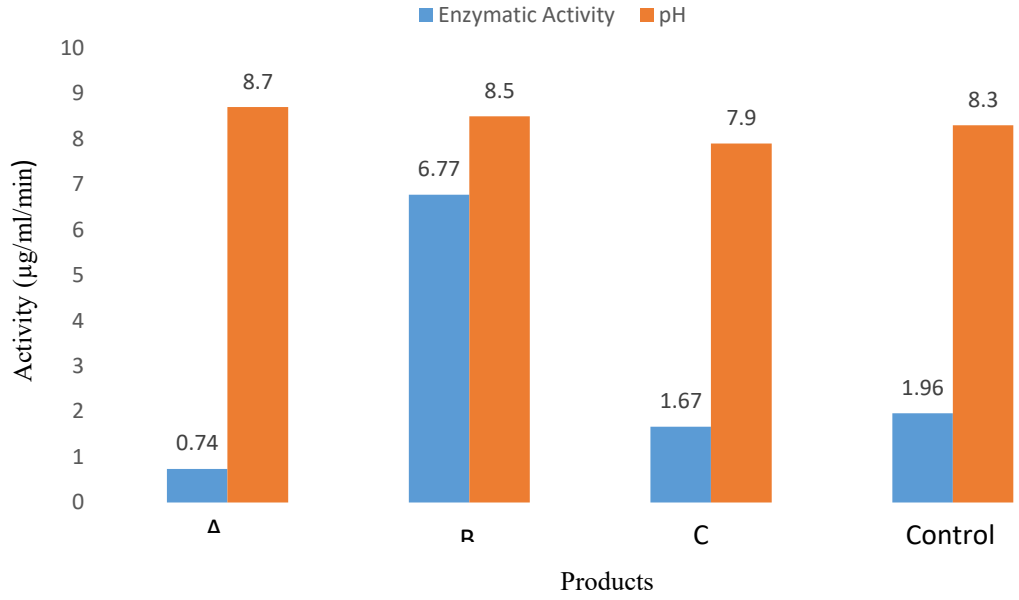

Figure 1: A graph showing the enzymatic activity of NILEST-Bate at different pH values

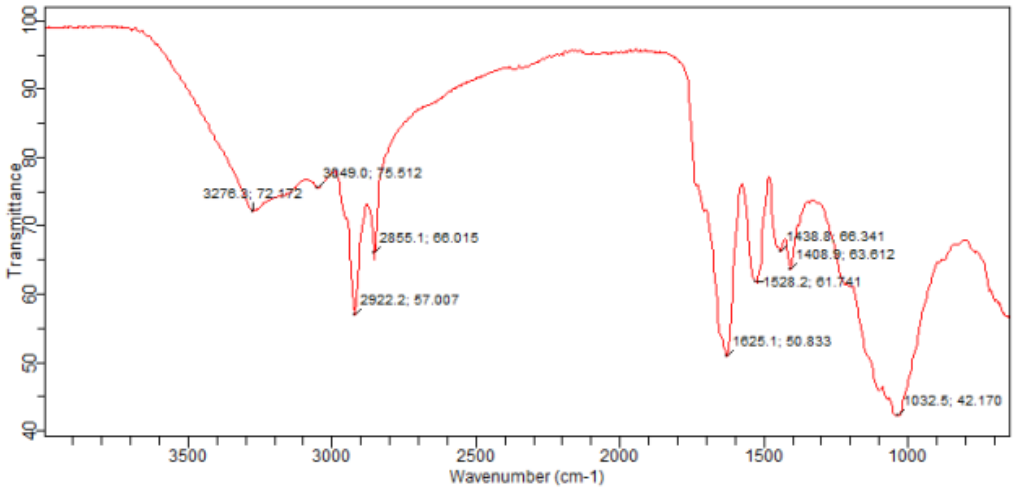

Figure 2: FTIR Spectrum of NILEST-Bate

Table 1 shows the result of physical tests carried on piece of leather produced with NILEST bate and commercial bate powder. The result shows that optimal treatment was produced with both bates when 1800 PU were used for 90 mins. At this concentration and temperature values, leather treated with NILEST-Bate had a greater tensile strength than that treated with commercial bate.

The difference recorded between the two bates product in tensile strength was 37.4 mm in a parallel direction and 29 mm in a perpendicular inclination of the leathers produced. Similarly, NILEST-Bate treated leather showed a greater strength indicated by tear strength, showing 12 mm and 7 mm increase in both parallel and perpendicular directions.

Again, the percentage elongation at break was also greater with 10 and 7.5% increases in parallel and perpendicular orientations respectively, when compared with the commercial treated leather under the same conditions.

Table 1: Physical Testing Assessment of Leather Produced using NILEST-Bate and Commercial Bate

Test	**Cut of Leather**	**Bating Time = 60 Mins**				**Bating Time = 90 Mins**			
		NILEST Bate (PU)		**Commercial Bate (PU)**		**NILEST Bate (PU)**		**Commercial Bate (PU)**	
		900	**1800**	**900**	**1800**	**900**	**1800**	**900**	**1800**
Tensile Strength ($Kgcm^{-2}$)	Perpendicular	138.1	160.2	132.5	155.0	160.4	220.5	142.6	191.5
	Parallel	148.4	169.2	139.4	160.1	169.5	232.6	142.4	194.2
Tear Strength ($Kgcm^{-1}$)	Perpendicular	32.6	37.4	30.2	34.6	35.6	47.5	35.8	40.5
	Parallel	38.3	42.0	35.6	39.2	37.5	57.4	36.2	45.4
Shrinkage Temp. at bating stage (^oC)		67	69	62	64	75	82	78	80
Elongation at Break (%)	Perpendicular	10.1	13.4	8.5	11.8	13.6	38.0	12.5	30.5
	Parallel	10.5	16.5	9.5	14.5	15.3	42.5	13.4	32.2

PU = Proteolytic Units (m^{-1})

Result for shrinkage temperature of the bating pelt shows 80 and 82 ºC for NILEST-Bate and commercial treated leather respectively, this indicates that the results are within the standard values.

The results obtained in this present study were in agreement with that earlier reported by Hameed *et al*. [6], while working on microbial bate and a commercial bate in leather treatment. The Fourier Transform Infrared Spectroscopy (FTIR) result (Figure 2) shows the presence of hydroxyl and aldehyde groups that indicates that the product is soluble in water.

Conclusion

The experimental bating trials using NILEST-Bate product on red goat skins produced a fine, soft and stretchy leather that is favourably comparable with that obtained using the commercial bate. Therefore, based on the present research, it can be concluded that NILEST-Bate can be used as a substitute for the available commercial bate used in leather manufacturing industries for bating process.

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