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FORMATION OF HYDROPHOBIZED NUTRIA VELOUR

Abstract. The formation of hydrophobized nutria fur velour has been carried out using the optimized alkenmalein acrylsyntane composition. Based on the implementation of the synthesized experimental plan “composition-properties of velour” by the modified McLean-Anderson method, the optimization of filling and hydrophobizing composition has been performed by Harrington method. The optimized composition involves the use of, wt. %: alkenmalein polymer – 54.1, polyacrylic emulsion Melio Resin A-821 – 18.8, reagent based on 2-naphtholesulfonic acid and dioxins-phenylsulfone – 27.1. The developed technology of forming hydrophobized nutria velour has been tested at the experimental production of leather enterprise (Chinbar Private Joint Stock Company, Kyiv, Ukraine). Nutria fur velour obtained by the developed technology is characterized by a significant increase in water resistance in dynamic conditions. The advantage of this technology is the production of fur velour with a higher yield of 5.4–5.6 % compared to the semi-finished chromium-aluminum tanning. The optimized filling and hydrophobizing composition can be effectively used in the technologies of manufacturing sheepskin and leather materials with high water resistance. According to the complex of properties, the obtained hydrophobized nutria velour is suitable for the production of uncovered items of various purposes, which will be used in extreme conditions.

Keywords: nutria velour, filling-hydrophobization, velour properties, McLean-Anderson method, multicriteria optimization, Harrington desirability function.

1. Introduction

The development of modern technologies for the production of new materials involves, first of all, the use of environmentally friendly chemical reagents, which allow expanding the range of products. At the same time, the use of such reagents also significantly improves existing technologies due to the application of new processes and operations. It concerns the production of fur materials, including velour, in particular the non-uniform structure obtained from natural raw materials. In this respect, an important aspect of the problem is the efficient use of fur raw materials that have not been used before for the manufacture of new uncovered products, namely nutria skins, which are not suitable for fur production because of the quality of hair covering.

The use of raw materials of nutria skin for velour resistant to the environment requires a significant modification of the porous structure of the skin tissue [1]. For this purpose it is necessary to carry out the processes of filling-hydrophobization of fur semi-finished products using the methods of mathematical modeling and multifactor optimization.

2. Literature analysis and problem statement

In technologies for the production of collagen-containing materials, including velour materials, scientifically sound processes of filling and modification of the fibrous porous structure of a semi-finished product are important. It stabilizes structural elements, which significantly affects the finite properties of the material. According to the analysis of research literature, a wide range of chemical reagents of different composition and structure is used for this purpose. In [2], the authors have investigated the effect of water-soluble polymers on the performance properties of natural materials. At the same time, there was an increase in the uniformity of physicochemical properties over the area of the semi-finished product, in particular thickness, density, strength, resistance to friction. In the formation of elastic natural materials, the authors of [3] have studied the effect of particle size of aqueous dispersions of acrylic acid copolymers on its strength and deformation properties. The dependence of physical and mechanical properties on the chemical composition of fluorine-containing aminopolymers has been explored [4]. Improved polishing quality of the semi-finished product is achieved. This will result in getting velour with a low even pile and necessary complex of physical and mechanical characteristics.

Alongside with the studies of the semi-finished product filling, they modify its porous structure, which is related, first of all, to the physicochemical blocking of hydrophilic groups of the filled structure of collagen, and can provide increased water resistance of the material. For this purpose, both monomeric and polymeric reagents of different molecular weights and chemical structures are used. This applies, in particular, to silanes, fluorocarbon and polydimethylsiloxane polymers, complex aluminum compounds [5]. For filling-hydrophobization of semi-finished products of chromium tanning copolymers of acrylic acid together with hydrophobic acryl monomers have also been used [6]. The result is a high degree of filling-hydrophobization of the natural material when using polymers, molecules of which contain straight hydrocarbon chains. The maximum effect of hydrophobization is observed at chain lengths above C16 [7]. In [8] the effect of fluorine-containing copolymer on the water resistance of natural material has been investigated. This results in an increase in the water resistance of the material, in particular dynamic waterlogging up to 55 min and a wetting angle of 155 ° with a fluorine content of 5 % in the copolymer. Hybrid polyfunctional polyurethanes are also known to improve water resistance and dirt repulsion of natural materials [9], but at the same time the exterior of the material deteriorates and its rigidity increases.

The authors of [10, 11] investigate the complex influence of polymers in combination with plasma treatment on the physical and chemical properties of the leather material. At the same time, the material strength was increased by 23 % and its water resistance by the duration of suction of water droplets by 86 %, while reducing its hygroscopicity by 76–87 % for semi-finished raw materials of cattle and sheepskin.

Thus, there are studies of the processes of filling the structure of tanned semi-finished products from natural raw materials of different origin and reduction of its hydrophilicity. The authors use monomeric and polymeric reagents of different molecular weights and chemical structures. This applies mainly to empirical studies. The formation of high quality natural materials from collagen-containing raw materials requires the development of scientifically sound technological processes and their computer optimization.

Taking into account the peculiarities of collagen-keratin structure, topographic unevenness of the skin tissue, features of its porosity and low durability in the formation of nutria skin velour, it is necessary to develop an optimized chemical composition of the filler-hydrophobic composition and determine the conditions for its effective use.

3. The purpose and objectives of the study

The purpose of the research is to study the process of hydrophobic velour formation from the skin of nutria by optimizing the structure of alkenmalein acrylsyntane composition. To achieve this goal, the following tasks have been set:

- synthesis of the experiment plan “structure of the composition-properties of velour” by the modified McLean-Anderson method;
- optimization of the structure of the filling and hydrophobizing composition by Harrington method;
- formation of hydrophobized nutria velour using the optimized structure of the filling and hydrophobizing composition.

4. Materials and methods of study of alkenmalein-acrylsynthan composition

The object of the study is the process of optimizing the filling and hydrophobizing alkenmalein-acrylsynthane (AM-AS) composition for the formation of high water resistance nutria velour. Raw materials of male nutria skins with coarse auburn hair of 24–25 dm^2 have been used after removing awn hair by epilation and chrome-aluminum finishing of a semi-finished product by technology [12] with obtaining temperature of hydrothermal stability (Γ_c) of skin tissue 90 °C. The studied composition AM-AC included alkenmaline (AM) polymer synthesized on the basis of α-alkenes $C_{20\text{–}24}$ and maleic anhydride with a mean molecular weight of $38 \cdot 10^3$, polyacrylic (PA) emulsion Melio Resin A-821 (Clariant, Germany) and the product of the synthesis of 2-naphtholesulfonic acid with dioxidiphenylsulphon (cyanant HC-DS). The composition has been dosed into the technological solution at a flow rate of 28 g/dm^3 for a ratio of water to the semi-finished product equal to 7.

Experimental studies of filled-hydrophobized nutria velour depending on the structure of AM-AC composition have been performed. Samples of the mined nutria semi-finished product have been selected by the method of proportional squares [13]. The effectiveness of using the composition for filling-extending the semi-finished fur velour has been determined in% by the difference of AM-AC composition used and its residue in the waste solution, water resistance of hydrophobized fur velour and its yield by area. Velour water resistance has been assessed by the dynamic method of the duration of water wetting on the device PVD-2 (Russia) when deforming the samples at a speed of 70 min – 1. Hydrothermal resistance of velour – at the initial reduction of the sample length when heated at a speed of 2.5–3.0 °C/min, porosity – the ratio of pore volumes and the original sample, physical and mechanical properties – using the bursting strength machine RT-250M, belt A (Russia) at a deformation rate of 80 mm / min according to the methods [13]. The yield of the velour area has been assessed by the ratio of the areas of hydrophobized and mined semi-finished product [12] under standard conditions.

The optimization of the structure of the filling and hydrophobizing composition consists in obtaining a D-optimal plan of the experiment, synthesized by a modified McLean-Anderson method [14], a mathematical model of the experiment “structure of the composition-property of velour” and determining the optimal content of the components of the composition by the Harrington method [15]. The optimum composition should correspond to the maximum duration for water wetting of the nutria velour, the maximum yield of its area and the effective use of the alkenmalein-acrylsynthan composition.

5. Obtaining a mathematical model “The structure of the filling and hydrophobizing composition – properties of nutria velour”

The influence of the components of the composition on the properties of nutria velour has been investigated during the formation of nutria velour. It is necessary to obtain a nonlinear mathematical polynomial model of “composition–properties”, which contains the components of the composition for each physicochemical indicator of hydrophobized nutria velour:

$$\hat{y} = \sum_{i=1}^{k} b_i x_i + \sum_{i=1}^{k-1} \sum_{j=i+1}^{k} b_{ij} x_i x_j + \sum_{l=1}^{k-2} \sum_{i=l}^{k-1} \sum_{j=i+1}^{k} b_{l\,ij} x_i x_j \, , \tag{1}$$

Where $\hat{y}$ is the predictive value of the physicochemical indicator; b_i, b_{ij}, are model coefficients; x_i is the content of the components of the composition in a coded form (i = 1, 2,…, k); k is the number of components; l, i, j are the sequence numbers of the interaction of the components of the composition.

It should be noted that in the model (1) the condition of normalization of the composition structure must be kept:

$$\sum_{i=1}^{k} x_i = 1 \tag{2}$$

Based on the previous studies, the limits of changes in the components in the natural values of X_i,, wt. parts, in the structure of the filling and hydrophobic composition (table 1) has been set.

Table 1 – Component restrictions of filling-hydrophobized composition

Limits of changing the components of the composition, in values			
natural X_i		coded x_i	
min	*max*	*min*	*max*
0.84	10.36	0.03	0.37
3.92	13.44	0.14	0.48
3.08	12.32	0.11	0.44
5.88	11.20	0.21	0.40

Note. Restrictions of the components of the composition, respectively, at the lower and upper levels: $0 \le X_i^{\min} \le X_i \le X_i^{\max} \le 1$ (i = 1, 2, ..., k). In this case, the components X_1 and X_4 in chemical composition correspond to alkenmalein polymer, in particular X_1 is the amount of polymer introduced at the beginning of the technological process of filling, and X_4 – at the final stage of hydrophobization.

The general mathematical model of "composition–properties" (1) for the structure of the composition is:

$$\hat{y}_i = b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_{12}x_1x_2 + b_{13}x_1x_3 + b_{14}x_1x_4 + b_{23}x_2x_3 + b_{24}x_2x_4 + b_{34}x_3x_4, \quad (3)$$

where $\hat{y}_i$ is the predicted value of the physicochemical index of fur velour, $i = 1 \div 3$; in particular, the effectiveness of the influence of the structure of AM-AC composition on the physicochemical properties of nutria fur velour has been assessed by:

y_1 – the efficiency of use of the composition, wt. %; y_2 – duration of dynamic wetting of fur velour, s; y_3 – yield of fur velour area, %; x_1, x_2, x_3, x_4 – correspondingly encoded values of the components of the composition: AM polymer, PA emulsion, NS-DS synthant and AM polymer.

To determine the coefficients of the mathematical model (3), the experimental data have been approximated according to the synthesized plan. The task of planning the experiment was to obtain the most theoretically possible amount of information with a minimum number of experiments, taking into account the normalization of the composition of the mixture (2), as well as the important requirement of the presence of all components in the structure:

$$x_i > 0, \; i = 1, 2, \dots, \; k. \quad (4)$$

The amount of experimental data can be substantially reduced by using the McLean-Anderson algorithm, which assumes that all possible combinations (more than 10^9) of N theoretical points of candidates selected by the McLean-Anderson algorithm [16] are provided, on condition that[1] $det|D|$→min. In order to establish the coefficients of model (3), we select the minimum number of experimental points n = 10.

The synthesized optimal experiment plan in a restricted area of synthesis (table 1) during 23.86 h is shown in table 2.

Table 2 – Experiment plan

Composition components	The structure of the mixture at the experimental point									
	2	3	4	5	10	12	14	27	29	34
x_1	0.210	0.200	0.030	0.030	0.030	0.370	0.190	0.370	0.030	0.225
x_2	0.140	0.480	0.460	0.320	0.140	0.140	0.140	0.225	0.480	0.335
x_3	0.440	0.110	0.110	0.440	0.440	0.110	0.270	0.195	0.195	0.110
x_4	0.210	0.210	0.400	0.210	0.390	0.380	0.400	0.210	0.295	0.330

The implementation of the synthesized plan has made it possible to obtain experimental data characterizing the influence of the structure of the filling-hydrophobic AM-AS composition on the technological, physical and chemical properties of nutria velour (table 3).

Table 3 – Properties of hydrophobized fur velour

Metric	The value of the metric at the experimental points									
	2	3	4	5	10	12	14	27	29	34
y_1	79.2	88.5	73.4	78.6	65.3	87.1	89.4	88.3	79.1	93.0
y_2	1390.0	1260.0	1630.0	1370.0	1840.0	1565.0	1780.0	1353.0	1410.0	1560.0
y_3	106.2	102.4	103.8	101.5	102.3	104.3	105.3	104.7	104.5	106.1

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[1] The total number of combinations of points of N candidates can be assessed by probability theory: $C_N^n = \frac{N!}{n!(N-n)!}$.

Dispersion matrix of a combination of candidate points $D = \left(F^T F\right)^{-1}$, where F is the matrix of the experimental plan with dimension $n \times t$; t is the number of coefficients of the model.

The required coefficients of the mathematical model (3) have been determined by the approximation of the experimental data given in Table. 2 and 3 using the least squares method. Based on the obtained experimental data, the mathematical model (5) has been constructed according to the above-mentioned technological, physicochemical parameters of the properties of the nutria velour, depending on the structure of AM-AS composition:

$$\begin{cases} \hat{y}_1 = -117.2034906\, x_1 + 1.92375297 x_2 - 8.67427379 x_3 + 64.14648706 x_4 \\ \quad + 444.6497106 x_1 x_2 + 467.4894979 x_1 x_3 + 374.8000603 x_1 x_4 + 437.5957898 x_2 x_3 \\ \quad + 87.20064507 x_2 x_4 + 146.8864982 x_3 x_4 \\ \hat{y}_2 = 402.3035289 x_1 - 254.5017831 x_2 + 494.9983683 x_3 + 3368.948843 x_4 \\ \quad + 3681.935211 x_1 x_2 + 1544.333049 x_1 x_3 - 1741.834756 x_1 x_4 + 2510.214516\, x_2 x_3 \\ \quad + 761.5901424 x_2 x_4 + 700.4074566\, x_3 x_4 \\ \hat{y}_3 = 62.55200238 x_1 + 69.72480492 x_2 + 74.7675243 x_3 - 5.302538861 x_4 \\ \quad + 36.20884176 x_1 x_2 + 95.63320238 x_1 x_3 + 251.4894287 x_1 x_4 + 23.05025504 x_2 x_3 \\ \quad + 264.0396943 x_2 x_4 + 230.9960487 x_3 x_4 \end{cases} \tag{5}$$

Thus, the obtained mathematical model “the structure of the composition - properties of nutria velour” can be subsequently used to optimize the alkenmalein-acrylsynthane composition in the manufacture of nutria fur velour.

6. Composition structure optimization by Harrington method

To find the optimal structure of AM-AC composition, a generalized Harrington D_f desirability function [14] has been used, according to which each techno-physicochemical indicator of nutria velour $\hat{y}_i$ is a partial function of the desirability of the technological indicator d_i,, can take corresponding dimensions y'_i from 0 to 1 depending on the component structure of the composition. The mathematical form of the desirability function for a three-component composition takes the form:

$$D_f = \sqrt[3]{d_1 d_2 d_3},$$

where; $d_i = \exp[-\exp(-y'_i)]$ $y'_i = b_0^{(i)} + b_1^{(i)} y_i$.

The coefficients are determined from the systems of equations:

$$\begin{cases} y_i'^{worse} = b_0^{(i)} + b_1^{(i)} y_i^{worse} \\ y_i'^{better} = b_0^{(i)} + b_1^{(i)} y_i^{better} \end{cases}$$

where $y_i^{worse}, y_i^{better}$ is respectively, worse and better values of the indicators y_i set by the researcher; $y_i'^{worse} = -\ln(-\ln d_{worse})$, $y_i'^{better} = -\ln(-\ln d_{better})$ is worse and better dimensionless indicators; respectively, the partial desirability functions d_{worse} and $d\,better$ are assumed to be 0.2 and 0.8.

The maximum of the desirability function D_f corresponds to the optimal composition $\bar{x}^{opt}$ having the best compromise values of the physicochemical parameters y_i.

Due to the optimization of the composition its optimal component structure has been obtained, wt. parts: $x_1 = 0.149$, $x_2 = 0.188$, $x_3 = 0.271$, $x_4 = 0.392$. The expected values of the original variables acquired the following values: $y_1 = 89.7$ %, $y_2 = 1789.0$ c, $y_3 = 105.35$ %.

Therefore, for filling-hydrophobization of 100 kg of extracted and epilated nutria semi-finished product after removal of moisture by centrifugation it is necessary to use alkenmalein-acrylsynthane composition of 19.6 kg of optimum structure: PA-emulsion – 3.7, synthane – 5.3, A-MS – 10.6. In order to activate the filling process, it is necessary to use 2.92 kg of alkenmalein polymer.

7. Testing the technology of hydrophobized nutria velour production using alkenmalein-acrylsynthane composition

The optimized structure of alkenmalein-acrylsynthane composition was used in the manufacture of hydrophobized nutria velour at Chinbar Private Joint Stock Company (Kyiv, Ukraine) from raw materials of fresh and dry canning weighing 19 kg. The epilated semi-finished product of the nutria skins after chromaluminum tanning was processed with the composition at a ratio of the masses of the working solution and the semi-finished product 7. In this case, in order to obtain hydrophobized nutria velour the working semi-finished solution was successively dosed with the components of AM at the temperature of 40–43 °C. At first, the AM polymer was added in the container, 15–20 min later a filling mixture of Melio Resin A-821 polyacrylic emulsion and 2-naphtholsulfonic acid synth with dioxidiphenylsulfone were added. In one hour – the remaining hydrophobized AM polymer. The total duration of the filling-hydrophobization process was 2.5 hours. Then the semi-finished product was pressed in a centrifuge to a humidity of 52–53 % and performed drying and moistening processes and operations to a moisture content of 12–14 % and polishing the skin tissue. After keeping hydrophobized nutria velour under standard conditions [13], its physicochemical tests were carried out.

According to the benchmark technology of processing nutria velour differed from the developed one as it had no filling-hydrophobization processes. In this case, nutria velour drumming was performed with an electrolyte-resistant emulsion of Trupol DL (Trumpler, Germany) at a temperature of 38–40 °C with a fat consumption of 2.5 g / dm^3 during 1 hour.

The results of the study of physicochemical properties of hydrophobized nutria velour are shown in Table. 4. The efficiency of the process of nutria velour hydrophobization with the use of AM-AS composition lies in a significant increase in the duration of dynamic wetting, compared with the material obtained by the benchmark technology. This increases the efficiency of AM-AC composition, as well as the yeild area of the material. At the same time, there is an increase in the thickness of the skin tissue of hydrophobized nutria velour and, accordingly, the uniformity of the material in topographic areas, which contributes to a more efficient use of its area when manufacturing goods. At the same time, the deformation properties of the hydrophobized nutria velour are better than the ones obtained in the process of benchmark technology.

Table 4 – Physicochemical properties of nutria fur velour

Indicator	Nutria velour obtained by technology	
	developed	benchmark
Dynamic water wetting, p	1800±20	25±5
Performance of the composition,%	87.2±2.5	79.3±3.6
Yeild area,%	105.6±0.3	100.0±0.3
Thickness of the skin tissue, mm	1.22±0.4	1.06±0.7
Tensile strength, MPa	1.2±0.20	1.09±0.25
Elongation at break,%	62.0±5.0	59.0±5.0
Elongation of skin tissue at load of 4.9 MPa,%, complete	28.0±2.5	22.0±2.6
– elastic	17.5±1.6	13.0±1.2
– residual	10.5±0.9	9.0±0.8
Porosity of skin tissue,%	62.0±3.0	65.0±4.3

Based on the research conducted in semi-production conditions, it can be assumed that the technology developed for the formation of hydrophobized nutria velour can be used to expand the range of fur raw materials and velour materials for the manufacture of products operated in high humidity conditions. The proposed technology can also be used without significant changes to existing processing technologies of other types of fur raw materials for the production of velour materials with high performance.

8. Conclusions

1. The process of formation of hydrophobized nutria velour from a fur semi-finished product after removal of the ostium hair has been investigated using computer optimization of the structure of alkenmalein-acrylsynthan composition. In the optimization of the structure of the filling and hydrophobizing composition, a modified McLean-Anderson method has been used, taking into account the type of mathematical model “the structure of the composition – properties of the hydrophobized material” and Harrington's desirability function.

2. The optimal structure of the filling and hydrophobising composition, including components, wt. %: alkenmaline polymer – 54.1, Melio Resin A-821 polyacrylic emulsion – 18.8, HC-DS sulphate – 27.1 at their consumption, respectively, % of the mass of the squeezed sulphurous semi-finished product: 10.6, 3.7 and 5.3 for the ratio of semi-finished product / technological solution 1/7.

3. Having applied the developed technology, which involves the combination of processes of filling-hydrophobization, nutria velour has been obtained with a significant increase in the duration of dynamic water wetting and increase the yield of material area by 5.6 % compared with the semi-finished chromaluminic finishing. The effective use of the alkenmalein-acrylsynthane composition provides for the formation of more homogeneous elastic material from porous raw materials technologically unsuitable for fur production.

4. The developed technology of formation of hydrophobized nutria velour with optimization of the structure of the filling and hydrophobizing composition can be effectively used in the production of sheepskin coat and leather materials of high water resistance. According to the complex of properties, the obtained hydrophobized nutria velour is suitable for the manufacture of uncovered articles of various purposes, which will be used in extreme conditions.

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ГИДРОФОБТАЛҒАН НУТРИЯ ВЕЛЮРІН ҚАЛЫПТАСТЫРУ

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ФОРМИРОВАНИЕ ГИДРОФОБИЗИРОВАННОГО ВЕЛЮРА НУТРИИ

Аннотация. В работе проведено формирование гидрофобизированного мехового велюра нутрии с использованием оптимизированного состава алкенмалеиново-акрилсинтанной композиции.

Целью работы является исследование процесса формирования гидрофобизированного велюра со шкурок нутрии путём оптимизации состава алкенмалеиново-акрилсинтанной композиции. Для решения данной цели поставлены следующие задачи:

– синтез плана эксперимента «состав композиции – свойства велюра» по модифицированному методу Маклина-Андерсона;

– оптимизация состава наполнительно-гидрофобизирующей композиции методом Харрингтона;

– формирование гидрофобизированного велюра нутрии с использованием оптимизированного состава наполнительно-гидрофобизирующей композиции.

Объектом исследования был процесс оптимизации состава наполнительно-гидрофобизирующей алкенмалеиново-акрилсинтанной (АМ-АС) композиции для формирования велюра нутрии повышенной устойчивости к воде. В работе использовано сырьё самцов шкурок нутрии с грубым остевым волосом площадью 24–25 дм^2 после удаления остевого волоса путём эпилирования и хром-алюминиевого додубливания полуфабриката с получением температуры гидротермической устойчивости кожевой ткани 90 °С. Исследованная АМ-АС композиция содержала алкенмалеиновый полимер, синтезованный на основе α-алкенов $C_{20–24}$ и малеинового ангидрида со среднечисловым молекулярным весом $38 \cdot 10^3$, полиакриловую эмульсию Melio Resin A-821 фирмы «Clariant» (Германия) и продукт синтеза 2-нафтолсульфокислоты с диоксидифенилсульфоном. В технологический раствор композицию дозировали с расходом 28 г/дм^3 при соотношении вода / полуфабрикат равному 7/1.

В работе проведены экспериментальные исследования наполненно-гидрофобизированного велюра нутрии в зависимости от состава композиции АМ-АС. Образцы додубленного полуфабриката нутрии отбирали по методу пропорциональных квадратов. Эффективность использования композиции при наполнении-додубливании полуфабриката мехового велюра определяли в % по соотношению разницы между расходованной композицией АМ-АС и её остатком в отработанном растворе к расходованной композиции, водостойкости гидрофобизированного мехового велюра и его выходу по площади. Водостойкость велюра оценивали динамическим методом по продолжительности водопромокания на

приборе ПВД-2 (РФ) при деформировании образцов со скоростью 70 мин$^{-1}$. Гидротермическую устойчивость велюра – по начальному сокращению длины образца при нагревании со скоростью 2,5–3,0 °С/мин, пористость – отношением объёма пор к объёму начального образца, физико-механические свойства – на разрывной машине РТ-250М, пояс А (РФ) при скорости деформирования 80 мм/мин. Выход площади велюра оценивали отношением площадей гидрофобизированного и додубленного полуфабриката у стандартных условиях.

Оптимизация состава наполнительно-гидрофобизирующей композиции состояла в получении D-оптимального плана эксперимента, синтезированного по модифицированному методу Маклина-Андерсона, математической модели эксперимента «состав композиции-свойства велюра» и определении оптимального содержания ингредиентов композиции методом Харрингтона. Оптимальный состав должен отвечать максимальной продолжительности относительного водопромокания велюра нутрии, максимальному выходу его площади и эффективному использованию алкенмалеиново-акрилсинтанной композиции. На основании реализации синтезированного плана эксперимента «состав композиции–свойства велюра» по модифицированному методу Маклина-Андерсона выполнена оптимизация состава наполнительно-гидрофобизирующей композиции методом Харрингтона.

Оптимизированный состав композиции предусматривает использование: мас. %: алкенмалеинового полимера – 54.1, полиакриловой эмульсии Melio Resin A-821 – 18.8, реагента на основе 2-нафтолсульфокислоты и диоксидифенилсульфона – 27.1. Разработанная технология формирования гидрофобизированного велюра нутрии апробирована в условиях опытного производства кожевенного предприятия ПрАТ «Чинбар» (г. Киев, Украина). Эпилированный полуфабрикат шкурок нутрии после хромалюминиевого додубливания обрабатывали композицией оптимизированного состава при соотношении масс рабочего раствора и полуфабриката равному 7/1. При этом для получения гидрофобизированного велюра нутрии в систему «рабочий раствор-полуфабрикат» последовательно дозировали ингредиенты композиции АМ-АС при температуре 40–43 °С. Сначала в баркас добавляли АМ-полимер, через 15–20 мин – наполнительную смесь полиакриловой эмульсии Melio Resin A-821 и синтан 2-нафтолсульфокислоти з диоксидифенилсульфоном. Ещё через 1,0 час – остальную часть АМ-полимера. Общая продолжительность процесса наполнения-гидрофобизации составляла 2,5 часа. Затем полуфабрикат отжимали в центрифуге до влажности 52–53 %, проводили сушильно-увлажняющие процессы и операции до содержания влаги 12–14 % и шлифование кожевой ткани.

Полученный меховый велюр нутрии по разработанной технологии характеризуется значительным повышением устойчивости к действию воды в динамических условиях. Преимуществом такой технологии является получение мехового велюра с большим выходом площади на 5.4–5,6 % по сравнению с полуфабрикатом хромалюминиевого додубливания. Оптимизированный состав наполнительно-гидрофобизирующей композиции может эффективно использован в технологиях изготовления овчинно-шубных и кожевенных материалов повышенной гидростойкости. По комплексу свойств полученный гидрофобизированный велюр нутрии пригоден для изготовления нагольных изделий разного назначения для эксплуатации в экстремальных условиях.

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