Jurnal Peternakan
Available online at:
http://ejournal.uin-suska.ac.id/index.php/peternakan
DOI:http://dx.doi.org/10.24014/jupet.v22i1:26054

Vol 22(1): 77-84, Februari 2025
p-ISSN: **1829-8729** | e-ISSN: **2355-9470**

Potential of Splitting Skin as Raw Material for Skin Crackers with Different Concentrations and Soaking Time in Vinegar

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• **Submitted:** October 13, 2023 • **Revised:** February 25, 2025 • **Accepted:** February 26, 2025

ABSTRACT. *Tannery solid waste, such as split skin residue, still contains lime, which is alkaline in nature, so it needs to be neutralized by adding vinegar. This research aimed to determine the best concentration and duration of skin immersion in acidic vinegar for water content, pH, texture, calcium content, and organoleptic splitting skin. This used an experimental method with a completely randomized design (CRD) with a 3 x 3 factorial pattern with three replications. Factor A (acetic acid concentration) consists of A1: 0%, A2: 3%, A3: 6%. Factor B (length of soaking) consists of B1: 8 hours, B2: 16 hours, B3: 24 hours. The variables observed were moisture content, pH, texture, calcium content, and split skin sensory. The results showed a significant interaction (P<0.05) between the concentration of acetic acid and the length of soaking on sensory skin color splitting. Still, there was no interaction (P>0.05) between the concentration of vinegar acid and the soaking time on water content, pH, texture, calcium content, and sensory aroma. From the research results, it can be concluded that the vinegar acid concentration of 3% and soaking time of 24 hours give optimal results with a moisture content of 46.12%, pH 7.33, texture 49.30 joules, calcium content 0.21%, sensory color 2.80 (white brownish) and sensory aroma 2.80 (no acid).*

Keywords: Vinegar acid concentration, splitting skin, soaking time, sensory, pH

INTRODUCTION

Skin, as results join in, can processed to become skin tan. Tanning skin use has the potential for development Because it produces filled skin (Kasim et al., 2015; Nurbalia, 2016). Besides, the tan combination produces leather quality with reduced chrome use (Kasim et al., 2014). Tanning with chrome produces dangerous waste. If it enters the chain, food will impact the ecosystem. However, chrome is dominantly used in the tanning industry skin (Saira & Shanthakumar, 2023; Ahmed et al., 2021; Yu et al., 2021).

Industry tanning skin also produces waste still solid _ can used, among others, the results of the splitting process. The splitting skin is the skin part that results from the division of leather. According to the Padang Panjang City, skin processing UPTD, as many as ± 7.2–9.6 tons of the total production of tanneries in a year is 48–60 tons, which skin waste is landfilled or for sale to island Java as raw material for making skin crackers.

Splitting skin is one of the waste products from leather tanning, which is abundant but underutilized from cowhide. Skin splitting is included in the stratum reticulare, corium bordering skin_with layer subcutis. Results study Sabtu et al. (2000) skin from a papillary stratum that is corium bordering skin_with the epidermis as material base skin tan produce crisp skin with same quality_as the stratum reticulare, so potential for developed used as raw material for skin crackers.

Raw materials with abundant potential can come from buffalo, cow, goat, and fish skin. Crispy beef skin has the lowest crude protein content, and crispy chicken skin compared to buffalo and fish skin (Susanti et al., 2022). Crispy skin is one of the superior products in West Sumatra (Julyarsi et al., 2021). In its development, this crispy snack is still constrained by the availability of raw materials from cow and buffalo slaughtering skin in Arsyla skin crackers in Padang (Novia et al., 2018) and Aulia skin crackers (Julyarsi et al., 2019). The use of dry salt-preserved skin as an alternative can improve the physicochemical quality of skin crackers produced by adding SMBS (Novia et al., 2024) or by soaking in an IMO solution of elephant grass (Ramadhan & Novia, 2024).

Limitations in getting skin raw cause several business people to crisp skin forced roll mats. Alternative material standards for crisp skin can originate from industry tanning skin. The lime still contained in the splitting skin is a problem and needs to be appropriately processed by removing the limestone in the skin by soaking it in an acid solution. Acetic acid is a hydrophilic (polar) protic solvent, similar to water and ethanol. The nature of vinegar acid (CH_3COOH) is that it is easily soluble in other polar or non-polar solvents such as water, chloroform, and hexane, so it is widely used in the chemical industry and laboratories.

Soaking the split skin using acetic acid solution aims to reduce the chalky substance found in the split skin and loosen the skin's connective tissue, which will cause the skin's collagen fibers to release so that the skin becomes wider and open the skin pores at the end of the process. According to Verheul (1998), acid-type chemicals can be used to increase protein solubility, which is expected to improve the properties of skin crackers. It is hoped that splitting skin crackers soaked in vinegar will become a popular product with the public and can add economic value to splitting skin waste. One of the uses of split leather waste from the tanning industry that has been researched is making glue by hydrolyzing collagen using a hydrochloric acid (HCl) catalyst (Hastutiningrum, 2009; Indrawijaya et al., 2020).

Histologically, Bligon goat skin collagen fibers experienced loosening at a concentration of 3%, dissolution at a concentration of 9%, and swelling at a concentration of 6% after being soaked in a weak acid solution (CH_3 COOH 0.5 M) for four days or 96 hours (Said, 2013). Soaking tilapia fish skin in a 5% lime solution for three hours produces the best results for skin crackers (Safitri et al., 2019).

Based on pre-research that has been carried out, soaking the split skin using 40 ml of vinegar and 600 ml of water for 24 hours can remove the chalk contained in the split skin, and the pH value of the solution was 6.73. This research aimed to determine the best interaction between concentration and soaking time for split skin in an acetic acid solution.

MATERIALS AND METHODS

Research Materials

The material used in the research was five pieces of splitting skin (tanned leather residue) obtained from the Padang Panjang City Skin Processing UPTD.

The materials used in this research were table vinegar with a concentration of 25% (CH_3COOH), water, and label paper. The equipment used in this research was a container (basin), knife, pH meter, cutting board, measuring cup, and roller.

This research was conducted at the Animal Products Technology Laboratory, Faculty of Animal Husbandry, the Water and Soil Laboratory, Faculty of Environment, and the Food and Agricultural Products Processing Engineering Laboratory, Faculty of Agriculture, Andalas University, Padang,

Research design

The method used in this research was a Completely Randomized Design (CRD) with a 3 X 3 factorial pattern with three replications. The treatments applied were:

Factor A was the concentration of vinegar acid, namely : A1 = 0% acetic aci; A2 = 3% acetic acid; A3 = 6% acetic acid

Factor B was the length of soaking, namely: B1 = 8 hours; B2 = 16 hours; B3 = 24 hours

$$Yij= \mu+\alpha i+\beta j+(\alpha\beta)ij+ \varepsilon ijk$$

Information: Yijk=Observation value for factor A at the ith level, factor B at the jth level, in the kth replication; μ= General average; αi=Effect of factor A at level I; βi=Effect of factor B at the jth level; (αβ)ij= Interaction between A and B at factor A at the ith level, factor B at the jth level; εijk= Experimental error for factor A of the ith level, factor B of the jth level in the kth replication/group

Variables were measured: moisture content using the oven method, pH (10 g skin/50 ml distilled water), hardness using Force George, level calcium, and sensory test. Organoleptic tests carried out on raw materials for skin crackers include color (brown = 1, brown wheat = 2, and white brownish = 3) and aroma (very acid =1, acid = 2, and No acid = 3).

This sensory test uses untrained panelists, students, and lecturers at the Animal Science Faculty, Universitas Andalas, which had 25 people. Each panelist was asked to fill out the questionnaire that had been given. Testing was carried out using ANOVA, and the test Duncan continued. Calculation of calcium content with formula :

mgCa/100g sample = (ml titration x N.KMnO4 x 20 x FP x 100)/(sample weight x 1000)

Research Implementation

Provision of raw materials; splitting skin was taken from the Padang Panjang City Tannery UPTD; the selected skin was made intact (not torn), without any defects or black spots on the skin's surface.

Drying; after the skin was obtained, the skin was first air-dried (temperature ± 30°C) without using direct sunlight until dry. Drying was done so that the split skin did not smell or rot.

Splitting skin cutting; splitting skin was cut into pieces first with a size of ±10cm x 6cm so that the skin was uniform and easy to soak in a container.

Immersion in water; before the split skin was soaked in acetic acid solution, the split skin was first soaked in water for ± 3 hours. The aim was to make the skin supple and pores open quickly.

Draining; after soaking in water, the skin was drained for ± 30 minutes. The aimed reduce the water content.

Soaking; in acetic acid solution (CH_3COOH). Split skin that had been drained was then soaked in a container containing acetic acid solution with a concentration of 0%, 3%, and 6% (factor A) for 8 hours, 16 hours, and 24 hours (factor B).

Draining; after the skin has been soaked using acetic acid solution (CH_3COOH), then drained for ± 30 minutes to reduce the moisture content.

RESULT AND DISCUSSION

Moisture content

Moisture content (%) in splitting skin results study can be seen in Table 1. Based on the results of diversity analysis, it shows an interaction between factor A (concentration of vinegar acid) and factor B (soaking time) influential but not significant (P>0.05) to moisture content of skin splitting after immersion. There was no relationship between the vinegar acid concentration and the soaking length. This was because the skin that had previously been split during the splitting process has a fast water absorption capacity, and in general, the structure of the collagen fiber network will quickly experience a swelling process, so the longer the soaking process takes. The acetic acid solution does not affect the moisture content contained in the resulting split skin. This thing influenced Still exists chalk on characteristic skin_releasing the water contained inside the skin (Chairi et al., 2023).

Table 1. Average moisture content of *splitting* skin after immersion

Factor A (Vinegar Acid Concentration)	Factor B (Length of Soaking)			Average
	B1	B2	B3	
A1 (0%)	43.62	45.00	43.62	44.08
A2 (3%)	43.19	43.48	46.12	44.26
A3 (6%)	45.47	42.86	43.03	43.79
Average	44.09	43.78	44.26	

The concentration factor and soaking time do not affect the water content, so most water remains in the skin, and some will come out. Skin soaked in 3% and 6% acetic acid solutions have the same water content as 0% acetic acid. Soaking the split skin in a 6% acetic acid solution for 24 hours can only loosen the connective tissue in the split skin, so the water content of the split skin with a vinegar acid concentration of 3% was the same as 6%. According to Said (2013), by soaking collagen in a 3% vinegar solution, the collagen structure has undergone a loosening process. However, by soaking for four days and a concentration of 6%, it experienced swelling and a denaturation process.

pH

Based on the research results using the concentration of vinegar acid and soaking time, the average pH value was obtained, as seen in Table 2.

Table 2. Average pH of *splitting* skin after immersion

Factor A (Vinegar Acid Concentration)	Factor B (Length of Soaking)			Average
	B1	B2	B3	
A1 (0%)	7.77	7.79	7.83	7.80
A2 (3%)	7.87	7.79	7.33	7.66
A3 (6%)	7.32	7.49	7.45	7.42
Average	7.65	7.69	7.54	

Table 3. Average texture of *splitting* skin after immersion

Factor A (Vinegar Acid Concentration)	Factor B (Length of Soaking)			Average
	B1	B2	B3	
A1 (0%)	60.87	55.50	51.17	55.85
A2 (3%)	60.37	55.61	49.30	55.09
A3 (6%)	60.44	55.43	49.27	55.05
Average	60.87	55.50	51.17	55.85

A diversity analysis showed that the interaction of acetic acid concentration and soaking time had no significant effect (P>0.05) on the pH value of the resulting split skin. There was no relationship between the vinegar acid concentration and the soaking length. According to Widati (2007), the liming process results in some of the fat being soaped into calcium soap, which is insoluble in water, so that the concentration of vinegar acid will be difficult for the split skin to absorb and the longer the soaking time, the more acid will not react in the collagen fibril network and will also be extracted.

pH value obtained range at neutral pH, namely 7.32-7.87. Results study. This mark was almost the same as the research of Anggara et al. (2022). Skin immersion in vinegar at Apple pH 5-6 for 24 hours produces a skin pH of 7.3-7.6. In Table 2, the average value of the pH content was almost the same. This was caused by splitting skin that previously underwent tanning and already contains Ca in the liming process. The effect of giving 3-6% concentration of acetic acid (CH_3COOH) for 24 hours when soaking the split skin can only loosen the connective tissue in the split skin, which causes the H^+ ions to only partially dissociate and produce deposits such as calcium salts so that the pH value on the skin splitting has no effect yet.

Texture

Texture is the primary assessment benchmark for types of food in the form of crackers. The texture of a food ingredient depends on the compactness of the constituent particles, size, shape, strength, uniformity of the particles, and the ease with which the constituent particles can be broken down, as seen in Table 3.

The results of the analysis of variance showed that for factor A (concentration of vinegar acid) and factor B (soaking time), it was known that the interaction of the two factors had no significant effect (P>0.05) on the resulting splitting skin texture. There was no relationship between the concentration of vinegar and the length of soaking on the texture of the resulting split skin. This was because the skin undergoes a soaking process in the tannery, wherein the raw skin is added to an acid-based solution; the skin is scraped on the inside and then rotated with a drum without water for 1/5 hour, which aims to make the skin fibers lose and easy to penetrate. Water causes the concentration of vinegar acid and the long soaking time that the split skin quickly absorbs water, and the skin collagen fibers quickly swell so that the split skin has almost the same texture. According to Said (2013), a concentrated vinegar solution and prolonged soaking play a role in loosening connective tissue, characterized by swelling of the skin's collagen fibers.

The similarities in the skin structure in the form of collagen from each ingredient can cause the absence of fundamental differences between each treatment. Table 3 shows that each concentration of acetic acid has almost the same average value for the resulting split skin. This was because the administration of several concentrations of vinegar has shown swelling so that it undergoes a denaturation process, resulting in the formation of large cavities between the collagen fiber tissue found in splitting skin.

Based on the effect of soaking time, the texture contained in the skin had almost the same average value. The results of this research show that the lowest splitting skin texture was

at a soaking time of 24 hours, namely 49.91 joules, which was caused by prolonged soaking would increase the expansion volume and can loosen the connective tissue, which was characterized by swelling of the collagen fibers in the split skin so that the texture value of the split skin was low or the texture of the split skin was flexible. Results of the study by Juliyarsi et al. (2020) provide an evaluation of the texture of shrimp crisp. The skin produced was as low as 132.84 N/cm^2.

Calcium Levels

The average test results for calcium content of split skin are presented in Table 4.

Table 4. Average Calcium content of *splitting* skin after immersion

Factor A (Vinegar Acid Concentration)	Factor B (Length of Soaking)			Average
	B1	B2	B3	
A1 (0%)	0.170	0.170	0.170	0.170
A2 (3%)	0.190	0.180	0.210	0.193
A3 (6%)	0.190	0.170	0.200	0.187
Average	0.183	0.173	0.193	

In the interaction between factor A (acidic acid concentration) and factor B (soaking time), there was no significant influence (P>0.05) on the calcium content of the resulting split skin. This shows that the concentration of vinegar acid depends on the length of soaking, and the same results are obtained for the calcium content of the splitting skin. Calcium levels produced range from 0.17-0.2% with 42.86-46.12% water content. Results study Widati et al. (2007) immersion of skin in solution chalk for 24 hours to 48 hours produced a rate calcium skin wet 0.1475-0.2650%; however, the water content was low, 19.58-16.60%. Making shrimp crisp tapioca with fortification shell egg chicken produces a rate of 5 g, namely 1.13% (Aprillita et al., 2018).

In Table 4, the addition of several concentrations of acetic acid and the soaking time does not affect the value of the calcium content of the split skin because soaking at 6% for 24 hours will only remove a few percent of the calcium content in the resulting split skin. In line with the study by Anggara et al. (2022), skin immersion in vinegar sugar palm with different concentrations for 24 hours no cause change Power tie crisp skin cow.

Sensory Test

A sensory test was carried out to see the quality of a product, determine consumer acceptability, and determine the panelists' assessment of the product produced. Observation of sensory properties consisting of color and aroma or odor of split skin is as follows:

Color

Based on data from the splitting skin color sensory test, the value ranges from 1.68 to 2.92, meaning it is close to wheat brown to brownish white. For more clarity, it can be seen in Table 5.

Table 5. Average sensory color of splitting skin color.

Factor A (Vinegar Acid Concentration)	Factor B (Length of Soaking)			Average
	B1	B2	B3	
A1 (0%)	2.36^{bc}	2.64^{ab}	1.80^{d}	2.27
A2 (3%)	1.68^{d}	2.20^{c}	2.80^{a}	2.23
A3 (6%)	2.20^{c}	2.64^{ab}	2.92^{a}	2.59
Average	2.08	2.49	2.51	

Note: Superscripts with different letters indicate significantly different effects (P<0.05).

Results of diversity analysis of the sensory test show that the interaction concentration of sour vinegar and the length of soaking has an effect (P<0.05) on the resulting splitting skin color. Duncan's test results for A3B3 treatment was significantly different (P<0.05) from A1B1, A1B2, A1B3, A2B2, A3B1 treatments and not significantly different (P>0.05) from A2B1, A2B3, A3B2 treatments (Table 5).

Table 5 shows that the A1B2 treatment (concentration sour 0% vinegar with a soaking period of 16 hours) had the lowest average, with an assessment of 1.68, which was chocolate wheat. The highest panelist assessment of splitting skin color was brownish white, namely A3B3 treatment (vinegar acid 6% and soaking time 24 hours) with a mean of 2.92. The hydrogen atom (H) in the carboxyl group (−COOH) in carboxylic acids such as acetic acid can be released as H+ ions (protons) so that the acetic acid concentration factor and the length

of time of the soaking process affect the collagen dissolution process so that it will make the color of the skin split cleaner. In line with the study's results by Suryaningrum et al. (2022), immersion of skin fish catfish in a vinegar solution of pH 4.7 for 15 minutes causes a change in skin color from black to grayish and swelling skin.

Aroma

Based on data obtained from the splitting skin aroma hedonic test, the value ranges from 1.56 to 2.8. For more clarity, it can be seen in Table 6.

Analysis results in diversity show that there was no interaction (P>0.05) between factor A (acidic acid concentration) and factor B (soaking time) on the splitting skin aroma sensory test. However, different concentrations of acetic acid (CH_3COOH) had a very significant effect (P<0.01) on the odor of split skin. The results of Duncan's test on the concentration of acetic acid (CH_3COOH) showed that the average assessment of splitting skin odor in treatment A1 was not significantly different (P>0.05) from treatment A2 but was very significantly different (P<0.01) from treatment A3.

Table 6. Average sensory aroma splitting skin after immersion

Factor A (Vinegar Acid Concentration)	Factor B (Length of Soaking)			Average
	B1	B2	B3	
A1 (0%)	2.44	2.68	2.80	2.64 [a]
A2 (3%)	2.56	2.80	2.80	2.72 [a]
A3 (6%)	1.88	1.56	1.92	1.79 [b]
Average	2.29	2.35	2.51	

Note: Superscripts with different letters indicate significantly different effects (P<0.05).

From Table 6, the results of the organoleptic test on the aroma of split skin using several concentrations of acetic acid and soaking time have an average value of between 1.56–2.8, meaning it was close to acidic to not acidic. This was because the acidic nature of vinegar has a sharp, sour taste and dissolves in water, so the process of soaking split skin with several concentrations of vinegar acid and the soaking time will directly influence the smell of split skin.

The A2 acetic acid concentration with an average rating of 2.72 was the highest value, and the lowest average was the A3 acetic acid concentration of 1.79. This is because acetic acid has a sharp, sour taste and is soluble in water. In liquid form, acetic acid contains –OH groups and can form hydrogen bonds with water. The hydrogen atom (H) in the carboxyl group (-COOH) in carboxylic acids, such as acetic acid, can be released as an H+ ion (proton), giving it a sour aroma. The aroma of this study, in line with research on skin crackers from tilapia fish soaked in 3% lime solution for 3 hours, was not significantly different from the control (only soaked in 5% lime solution) (Safitri et al., 2019).

CONCLUSION

Based on the results of this research, it can be concluded that there was no interaction between the concentration of acetic acid and the length of soaking on water content, pH, texture, calcium content, and organoleptic odor. However, there was a genuine effect on the interaction between the concentration of acetic acid (CH_3COOH) and the time of soaking on sensory color. The acetic acid concentration of 3% and soaking time of 24 hours give optimal results seen from the moisture content of 46.12%, pH 7.33, texture 49.30 joules, calcium content 0.21%, organoleptic color 2.80 and aroma organoleptic 2.80.

CONFLICT OF INTEREST

We have no conflict of interest with any financial, personal, or other relationships with other people or organizations related to the material discussed in the manuscript.

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