Analysis of Variance in Moisture Content of Synthetic Leather Made from Organic Waste

L Chairani[1,3]**, D Rimantho**[1,4]**, and V Anggit**[1,5]

[1]Pancasila University, Jl. Srengseng Sawah, South Jakarta, Indonesia
[3]laelachairani@univpancasila.ac.id,[4]dino.rimantho@univpancasila.ac.id,
[5]vector_anggit@univpancasila.ac.id

Abstract. Nowadays, leather is used to make fashion products and several other household appliances. The characteristics of leather that give a classic impression, durable, soft, and attractive texture, making leather not outdated with one of its disadvantages being that is expensive. Therefore, synthetic leather is made with some raw materials that are not environmentally friendly such as waxes and dyes. The use of dyes and other chemicals has an impact on environmental pollution. Researchers are trying to create eco-friendly synthetic leather with plant-based materials, such as cactus leaves, mushrooms, banana leaves, pineapple fruit, various flowers, and recycled paper. In this research, the basic material used is orange peel with one of the raw materials in the manufacturing process being water. According to the stages of using DoE replication, five samples were obtained to be tested for moisture content. The maximum moisture content allowed is 20% (SNI). The laboratory test results showed that the moisture content was between 17% - 20%. Using one-way ANOVA, the results showed that the five samples had different means with a p-value of 1.06E-17.

Keywords: leather, eco-friendly, plant-based, orange peel, ANOVA

1. Introduction

Nowadays, leather is used to make fashion products and other household items, such as upholstery for living room sofas/chairs. The characteristics of leather that give a classic, strong, and durable impression with a soft and attractive texture, make leather a raw material that never goes out of style. One of the disadvantages is the high price, this is indicated by the use of genuine leather as raw material in fashion products with well-known brands [1]. Synthetic leather was created to be used for all levels of society. Synthetic leather is artificial leather made from chemical engineering involving various raw materials such as waxes and dyes to produce a color and texture resembling genuine leather. Synthetic leather is divided into two types, which are polyurethane (PU) and polyvinyl chloride (PVC) [2]. The difference between these two types of synthetic leather is the skin-forming layer that can produce pores in the leather. The use of dyes and other chemicals and the non-recyclability of the leather have an impact on environmental pollution, due to the release of chemicals and waste from this process [3]. In recent years, researchers have tried to solve the environmental pollution from the manufacturing process of synthetic leather by creating plant-based synthetic leather, such as cactus leaves, mushrooms, banana leaves, pineapple, various flowers, and recycled paper.

Some fashion industries are starting to use wood, fruits, cactus, and raw materials that come from waste and are easily biodegradable [2]. The advantages of organic waste are soft, durable, and easy maintenance [1]. The organic waste used as a base material in this study is orange peel, see Figure 1.

Orange peel contains phenolic compounds (phenolic acids, flavanones, and polyethoxylated flavones), carotenoids, and ascorbic acid. Phenolic compounds have benefits such as anti-microbials, antioxidants, anti-cancer, anti-inflammatory, and anti-allergic, and contain a source of dietary fiber [4]. Orange peel contributes of 40-50% of the total weight of the fruit, also orange peel from the beverage industry and households, becoming one of the wastes that are found around us [5]. Generally, orange peels are used as a source of pectin for animal feed and fertilizer. Currently, several studies have focused on waste treatment systems, such as conversion to provide added value [5].

Figure 1. Orange Peel

Orange peels have several advantages, including the amount and cheap biomass. Processing orange peels with the help of Microbial Fuel Cells (MFC) can generate electricity by degrading waste, so it can be an alternative to solving environmental problems [6]. Other research that has been done to reduce waste is to process orange peel into eco-enzyme. Eco-enzyme is a product of a complex organic solution produced from the anaerobic fermentation process of organic waste, sugar, and water. This product is made from the remains of household waste, especially fruits, and vegetables, which are fermented for three months [7]. In this study, the orange peel will be used as the material for making synthetic leather which can be seen in Figure 2.

Figure 2. Synthetic Leather From Orange Peel

One of the raw materials used in the process is water, so this research was conducted to determine the moisture content, because molds, yeasts, bacteria, and fungi can grow on materials with a high water activity value (Aw value). The Aw value can be reduced by using compounds that can bind water, or using drying techniques, either by drying or artificial drying equipment [8]. Therefore, this study was conducted to determine the moisture content and whether is there a different mean of the five samples.

2. Methods

This research uses an experimental design to reach valid, effective, and efficient conclusions. One method that is often used in research is the Design of Experiment (DoE). DoE is a series of procedures consisting of several stages, from planning to the interpretation of results. There are five basic principles in DoE, namely randomization, repetition/replication, blocking, orthogonality, and factorial experiments [9]. This research will use the principle of repetition/replication, where experiments are conducted with

the same treatment to increase the precision of the experimental results. The test results are carried out on the resulting moisture content and then analyzed with one-way ANOVA to determine whether there is a real difference between the samples. One-way ANOVA is a statistical method for testing the means of 3 or more groups. One-way ANOVA is usually used when a test has only one independent variable [10]. The stages of this research are as follows:

1) Drying the orange peel.
2) Shredding and crushing of orange peel.
3) Sifting.
4) Mixing with alginate, glycerin, cooking oil, and clean water.
5) The solution then allowed to stand overnight to release air.
6) Put the dacron into the mold.
7) Put the solution into the mold, then spray with Calcium Chloride.
8) Flatten the solution under the mold.
9) Dry it.
10) Five samples that have been dried then tested for moisture content in the test laboratory.

The results of the moisture content were then analyzed using one-way ANOVA with a confidence level of 95%, to determine whether is there a different mean of the five samples.

The following hypothesis in this study are:

$$Ho: \mu A = \mu B = \mu C = \mu D = \mu E$$
$$Ha: \text{not all means are equal}$$

57.

3. Results and Discussion

58. The results of testing the five samples, obtained moisture content for 6 replicate tests as shown in Table 1.

59.

60. **Table 1**. Moisture content test results

Samples	Testing (%)					
	I	II	III	IV	V	VI
A	18,35	17,9	18,05	18,10	17,95	18,25
B	17,69	17,55	17,29	17,25	17,00	17,85
C	19,36	19,21	19,41	19,62	19,07	19,11
D	17,82	17,35	17,79	17,58	17,24	17,10
E	20,52	20,14	20,74	20,77	20,47	20,48

61. According to the SNI of stingray leather as the basic material for making bags, wallets, belts, and other accessories, the maximum moisture content is 20% [11], this value, when compared with the test results of five samples, has a moisture content below 20%, except sample E. However, if using SNI sheepskin for making leather jackets, the maximum moisture content is 18% [12], this value when compared with the test results of five samples is known that only samples B and C are below 18%. Therefore, to achieve the standard, it is necessary to increase the length of drying time or use other drying alternatives such as drying machines. Furthermore, the moisture content of each sample was then calculated as the variance value of the test results using equation 1, and the results can be seen in Table 2.

62.
$$S^2 = \frac{\sum_{i=1}^{n}(xi - \bar{x})^2}{n-1} \tag{1}$$

63.

64. **Table 2.** The mean and variance of the sample

Groups	Count	Sum	Average	Variance
A	6	108,5956	18,09926	0,030083
B	6	104,6348	17,43913	0,098808
C	6	115,7681	19,29469	0,043242
D	6	104,8888	17,48147	0,088022
E	6	123,1113	20,51854	0,051248

65.

66. The variance allows researchers to understand the breadth of diversity within a sample or the entire population, as the variance will often explain any outliers in the population. In an entire data set, variance is essential for tracking outliers, which are data points that are not close to the mean. The research data has a low variance, which indicates that the data is close to the mean. Then the analysis continued with one-way ANOVA using equations 2, 3, and 4.

67. $Sum\ of\ Squares\ (Total) = SS(Between\ Groups) + SS(Within\ Groups)$

68.
$$\sum_{i=1}^{a}\sum_{j=1}^{ni}(Yij - \bar{\bar{Y}})^2 = \sum_{i=1}^{a}ni(\bar{Y}i - \bar{\bar{Y}})^2 + \sum_{i=1}^{a}\sum_{j=1}^{ni}(Yij - \bar{Y}i)^2 \tag{2}$$

69. Following definitions;

70. n_i = number of observations for treatment i

71. N = total number of observations

72. Y_{ij} = The jth observation on the ith treatment

73. $\bar{Y}i$ = The sample mean for the ith treatment

74. $\bar{\bar{Y}}$ = The mean of all observations

75.
$$Mean\ Squares\ (MS) = \frac{SS}{Degrees\ of\ Freedom\ (DF)} \tag{3}$$

76.
$$F = \frac{MS\ Between\ Group}{MS\ Within\ Group} \tag{4}$$

77.

78. The results of calculations using equations 2, 3, and 4, the values of SS, MS, and F are shown in Table 3.

79. **Table 3**. Results of one-way ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	42,04389	4	10,51097	168,7681	1,06E-17	2,75871

Within Groups	1,557014	25	0,062281
Total	43,6009	29	

80. The F value (F count) is greater than the F crit (F table) or the p-value is lower than 0,05, indicating that the null hypothesis (Ho) is rejected. This shows that not all means are equal.

81.

4. Conclusion

82. Based on the results of testing and data analysis, it is known:

1) The moisture content of the five samples is between 17%-20%. when viewed from SNI for leather as raw material for making wallets, bags, and other accessories, sample E is above SNI (maximum 20%). When viewed from SNI for making leather jackets, only samples B and D are in accordance with SNI.

2) The null hypothesis is rejected with F count > F table or p-value < 0,05, this indicates that not all means are equal (p-value = 1,06 E-17).

83.

84. 5. References
[1] Hafez N, Hassan N 2015 An investigation into the physical and functional properties and sew ability of Faux leather. *International Design Journal* **Volume 5** Issue 2 pp 517-524.
[2] Gupta R, Dave D 2021 Biomaterial: A Sustainable Alternative to Animal Leather and Synthetic Material. *Annals of R.S.C.B.D* **Vol 25** Issue 6 Pages 7317 – 7331.
[3] Elkhateeb WA, Galappaththi MCA, Wariss HM, Haesendonck KV, Daba GM 2022 Fungi-derived leather (Mushroom leather). *MycoKing* 1: 1-9.
[4] Mustafidah R, Asyari RP, Velayati JM, Sayekti T 2022 Pemanfaatan Limbah Kulit Jeruk sebagai Fortifikan Guna Memperkaya Nilai Gizi pada Cokelat. *Jurnal Tadris IPA Indonesia* **Vol 2** No.2 pp. 121 – 130.
[5] Indriastuti NA and Aminah S 2020 Potensi Limbah Kulit Jeruk Lokal sebagai Pangan Fungsional. *Prosiding Seminar Nasional Teknologi Pangan* **Vol.13** No.2 pp. 122 – 129.
[6] Nugraha BA and Sopandi TP 2022 Pengolahan Limbah Kulit Jeruk sebagai Sumber Energi Terbarukan di Desa Selorejo, Kabupaten Malang; Literature Review. *Jukung Jurnal Teknik Lingkungan* **8**(1): 1 – 17.
[7] Sidauruk WS, et al 2022 Sosialisasi Pengolahan Limbah Kulit Jeruk menjadi Produk Eco Enzyme di SMPN 3 Siak Kecil Kabupaten Bengkalis. Jurnal Pengabdian Nasional (JPN) Indonesia, **Vol. 3** No.2 pp. 135 – 140.
[8] Leviana W and Paramita V 2017 Pengaruh Suhu terhadap Kadar Air dan Aktivitas Air dalam Bahan pada Kunyit (*Curcuma Longa*) dengan Alat Pengering *Electrical Oven. METANA* **Vol. 13**(2): 37 – 44.
[9] Muttaqin BIA 2019 Telaah Kajian dan *Literature Review Design of Experiment* (DOE). *Journal of Advances in Information and Industrial Technology (JAIIT)* **Vol.1** No.1 pp. 33 – 40.
[10] Ananda R and Fadhli M 2018 *Statistik Pendidikan Teori dan Praktik dalam Pendidikan* (Medan: CV. Widya Puspita)
[11] Kusmaryanti T, Ibrahim R, Riyadi PH 2016 Pengaruh Perbedaan Bahan Penyamak terhadap Kualitas Kulit Ikan Pari Mondol (*Himantura gerrardi*) Tersamak. *Jurnal Saintek Perikanan*, **Vol. 11** No. 2: 140 – 147.

[12] Sutyasmi S 2017 Efektivitas Penggunaan Gambir sebagai Bahan Penyamak Nabati Sistem C-RFP untuk Pembuatan Kulit Jaket dari Kulit Domba. *Majalah Kulit, Karet, dan Plastik* 33(1), 11-18.