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The influence of solar tunnel dryer on the quality of karupuk jangek (case study: Aulia MSME in Jorong Aro Kandikia, Tilatang Kamang Agam Regency)

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Abstract. This study aimed to determine the influence of drying time on the quality of karupuk jangek with solar tunnel dryer to protein content, fat content, texture test and organoleptic test. The raw material of this research was cowhide obtained from Animal Slaughterhouse in Bukittinggi, by using 50 kg of Simmental Crossbreed, aged 2 years. The research method used Completely Randomized Design consisting of 4 treatments. The treatments were drying time A (1 day), B (2 days), C (3 days), D (4 days). The results showed that the influence of drying time on quality of karupuk jangek with solar tunnel dryer on 3 days gave best result of protein content of 58.88%, fat content of 13.69%, texture test with average 210.92 N/cm², a colour organoleptic test 2.06, flavour 2.02 and texture 2.12 showed quite like.

1. Introduction

Cracker is a snack. Crackers can come from a variety of foods, for example from cowhide, buffalo skin and other animal skins. Skin-based crackers are also called karupuk jangek. In West Sumatra there is a lot of traditional and modern processing of karupuk jangek using a drying machine, in general, the karupuk jangek industry dries by drying the processed products directly in the sun with a container from wood and nets. It really depends on weather conditions, and work efficiency is not optimal and the resulting products are less hygienic. The traditional drying process takes 5-7 days directly. To increase the production capacity, a dryer is needed to speed up the drying process.

Most of the cowhide is processed into tanning materials for clothing products. But the tendency of this leather product is decreasing, because for the current clothing, consumers prefer synthetic materials that are cheaper. From an economic standpoint, the prospect of karupuk jangek is more profitable than leather. This is because, in most restaurants, stalls, and souvenir shops, many of them provide karupuk jangek. The price of these karupuk jangek varies depending on the size of the package. For 1 kilogram of raw karupuk jangek (latua), the price was 150,000 IDR, whereas for fried karupuk jangek the price is more expensive, whereas a 1 kg package cost 190,000 IDR [1].

The availability of cowhide raw material in line with the strategic program of animal husbandry development in West Sumatra Province in 2011 was to increase beef cattle population in 2010 from 510,276, in 2014 to 595,843 which resulted in an increase in beef cattle population by 85,367. The increased beef cattle population to achieve self-sufficiency in beef has also increased the availability of skin as a by-product.



Kanagarian Gadut is located in Tilatang Kamang Subdistrict, Agam Regency, located approximately 6 kilometers from the center of the Bukittinggi tourist town, which has an area of about 1,450 Ha (Gadut) [2]. This nagari is a very potential nagari, especially in agriculture and animal husbandry, because most of the population make a living from farming and raising livestock. Geographically, Gadut is closer to Bukittinggi than the capital of Agam Regency in Lubuk Basung, which is about 60 km away. So the closest access is Bukittinggi, so it is not uncommon for many residents to work in the city and live in this region.

In Jorong Aro Kandikia, Kanagarian Gadut, a group of non-formal household businesses that manage the manufacture of karupiak jangek from cows is established. This business group is managed by a young man named Aulia, established since the beginning of 2006. Currently producing as much as 2-3 pieces of cowhide/day, except during Eid Hajj can produce 60 pieces of cowhide/day. Raw materials are purchased from slaughterhouse in Bukittinggi City. In the Aulia MSME, raw cowhide is processed directly and not through preservation. Problems that arise when there is a lot of raw cowhide, which must be directly processed, boiled, and dried. For this reason, technology is needed so that drying can be shorter with the solar tunnel dryer in Aulia MSME.

Based on the report [2] that the duration of drying with sunlight on karupiak jangek is about 7 days depending on the weather, and based on samples taken, crackers in a raw state after being dried in 2 days had a water content of around 41.62%. In this study will be seen the effect of cowhide drying time on the quality of karupiak jangek with solar tunnel dryer.

The problem that occurs is how the effect of cowhide drying duration on the quality of karupiak jangek with solar tunnel dryer, on protein content, fat content, texture test, organoleptic test. While the purpose of this research was to test the solar tunnel dryer to get the characteristics of drying of protein content, fat content, texture test and organoleptic test of final drying and quality of cowhide crackers. The benefits of research are to obtain good drying results by using a dryer (solar tunnel dryer) that is suitable for small industries or household businesses and is suitable for use. Get quality karupiak jangek that are in accordance with Indonesian National Standards.

2. Material and method

2.1. Material

The material used in this study was 1 piece of cowhide weighing 50 kg which was purchased from the slaughterhouse in Bukittinggi City, with Simmental Crossbreed cow, aged 2 years. Fat content test and for protein test used methods SNI 01- 2891-1992 [3], concentrated sulphuric acid reagents, mercury oxide (HgO), potassium sulphate (K₂SO₄), Sodium Hydroxide solution, Sodium thiosulfate, solution of saturated boric acid (H₃BO₃), solution of Hydrochloric Acid (HCL), boiling stones, distillate water, MM indicator, salt, phenolphthalein indicator 1%.

The tools used in this study were solar tunnel dryers, knives, analytical scales, cauldrons, furnaces, pans, spatulas, ovens, aluminium plates, desiccators, cup clamps, soxhlet extraction tools with condensers and fat flasks, electric heaters, and steam baths, filter paper, cotton, Kjeldahl heater, Kjeldahl flask, complete distillation equipment, 50 ml burette, 100 ml measuring flask, measuring pipette of various sizes, 250 ml Erlenmeyer, beaker glass, stirrer, drop pipette, Brookfield Texture Analyser CT-3.

2.2. Method

This research was conducted by an experimental method by using a Completely Randomized Design (CRD) with 4 treatments 5 replications. The treatment was cowhide drying time to improve the quality of karupiak jangek with solar tunnel dryer for protein content, fat content, texture test, and organoleptic test. The treatments are A = 1 day drying time, B = 2 days drying time, C = 3 days drying time, D = 4 days drying time. The data obtained were processed statistically by using diversity analysis from a Completely Randomized Design (CRD).

2.3. Measured variable

a. Protein Content [3]

The proximate test was done at Integrated Laboratory Instrument for Food Technology in Universitas Andalas. Kjeldahl methods of analysis were used to determine protein content, analysing methods from SNI 01- 2891-1992

b. Fat content [3]

Used Soxhlet methods to determine fat content, analysing methods AOAC 1990.

c. Texture test (*Texture profile method*)

The textural characteristics of *karupuak jangek* analysed were the hardness, determined using Texture Profile Analysis method (TPA). Test performed on a Brookfield CT3 Texture Analyser [3]

d. Organoleptic test [4]

The organoleptic test was held in campus laboratory after lunch break. Panellist were the same for triangle test and hedonic test. They were 25 semi-trained panellists who did not have any oral disease that would impair taste on the day of the experiment (flu, cold, etc). Prior to the testing, each *karupuak jangek* sample was individually sealed in a pouch and coded with a three-digit number. Drinking water was provided for mouth rinsing between samples. Hedonic test was used to determine the most panellists liked formulation for the *karupuk jangek* according to colour, flavour, texture, and taste parameter. Panellists were evaluate the parameters using 3- point hedonic scale (1=dislike, 2 = quite like,3=like).

2.4. Research implementation

Testing was carried out by using a solar tunnel dryer to determine the levels of protein, fat content, texture, and organoleptic. To find out the time needed for drying *karupuak jangek* by using a solar tunnel dryer. (a) Preparation of a solar tunnel dryer by checking the condition of the dryer components and ensuring that the solar tunnel dryer is ready to use, and (b) Wash solar tunnel dryer so that it is ready to use and in a clean condition.

2.5. Working procedure of *karupuak jangek* production

Cowhide is delivered by suppliers from Bukittinggi slaughter house directly to the Aulia MSME by pick up car. The skin cut into 4 parts. Boil in water for 5 minutes in a drum with a temperature of 100 °C. Dry skin from the drum and scrap it off. On the second boiling, the skin is half cooked, the skin is boiled again for 30 minutes at 90 °C. Then remove the skin and wash thoroughly with running water so that no more dirt is left. After the skin is clean, hang the skin to dry. Meat that is attached to the skin is removed with a sharp knife, and the fur that is still attached to the skin is removed until nothing is left. Then chop with a leather cutting knife. Skin that has been chopped, then soaked with water overnight, in order to remove the sap attached to the skin. After that, wash thoroughly until all the sap comes out. After the skin is clean, sprinkle the skin with salt, in order to give salty flavour to *karupuak jangek*.

Then dry the skin in accordance with treatment A = 1 day, B = 2 days, C = 3 days, D = 4 days. A day is means 24 hours, with temperature 50-60°C, and RH 60-70%. After the skin is dry, *latua* is carried out with a temperature of 90 °C (frying with less hot oil): (a) The first *latua* until it looks white one by one in 1-2 hours; (b) The second *latua* until whitey in 1-2 hours; (c) Third *latua* until all look white and fluffy. Cool the skin that has been performed a *latua* in 1 x 24 hours. The skin is ready to be fried at a temperature of 130 °C. *Karupuak jangek* are tested to determine protein content, fat content, texture test, and organoleptic test.



Figure 1. Solar tunnel dryer

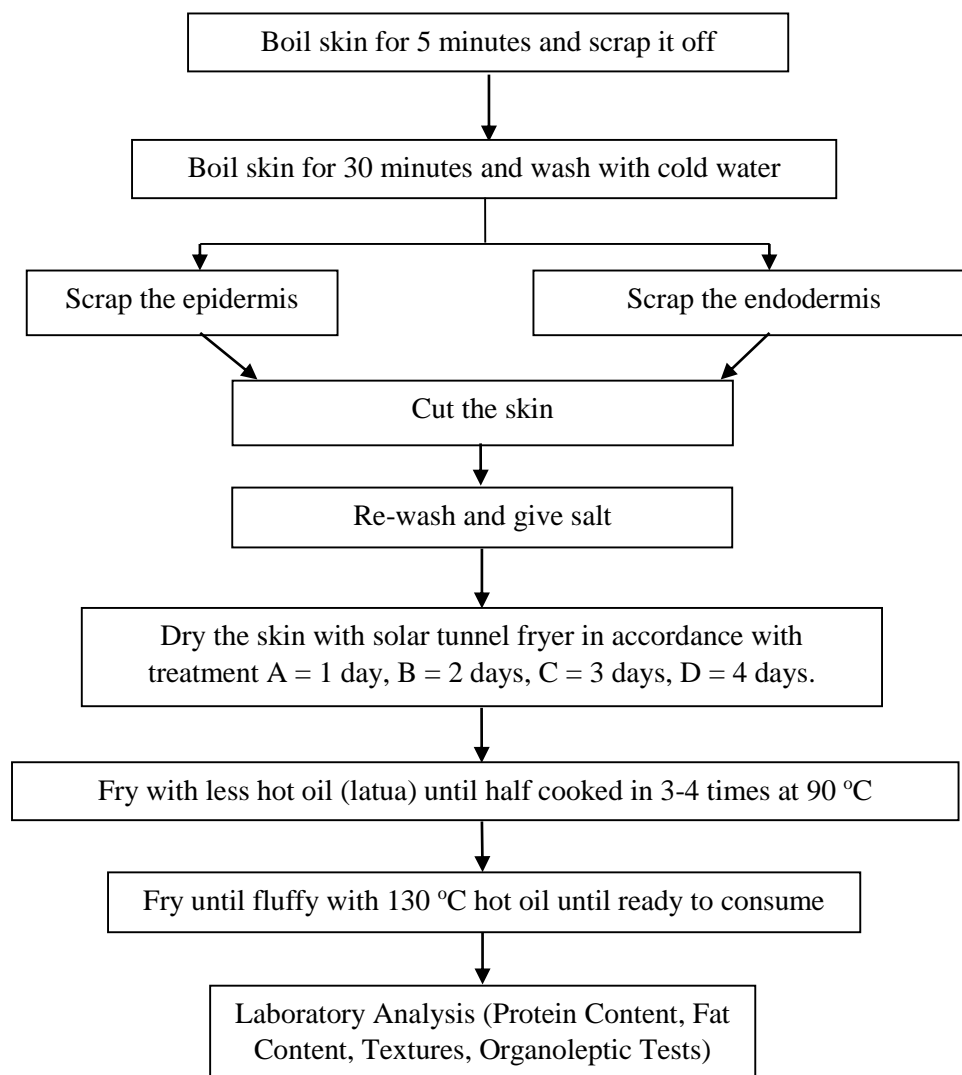


Figure 2. Flow chart of karupuak jangek production [5]

3. Results and discussion

3.1. Protein content

The protein content of karupuak jangek can be affected by the drying time causing protein denaturation. Research on karupuak jangek is very rare, so to compare with other crackers, it will cause differences. Generally, research on karupuak or crackers comes from dough derived from flour. Research [6] protein

content of karupuak jangek are 63.90-64.71%. The average protein content of karupuak jangek in different drying time treatments can be seen in Table 1.

Table 1. Average protein content of karupuak jangek

Treatment	Average (%)
A	52.59 ^b
B	52.52 ^b
C	58.88 ^a
D	58.04 ^a
SE	0.47

Description: Superscript in the same column shows significant influence ($P > 0.05$). SE = Standard Error.

The results of the analysis (Table 1) showed that the influence of drying time on the quality of karupuak jangek with solar tunnel dryer had significant influence ($P > 0.05$) on karupuak jangek protein content. In this study, it was clear that treatment C (drying time 3 days) and D (drying time 4 days) had a very significant influence on treatment A (drying time 1 day) and B (drying time 2 days). As can be seen from the results of the study with the longer drying time of treatment C (drying time 3 days) gave the highest results in the protein content of karupuak jangek of 58.88% and the lowest protein content was found in treatment A (drying time 1 day) of 52.59%. An increase in protein in each treatment due to the longer time of the drying process which will cause a decrease in the concentration of water in the skin. And the low protein in treatments A and B was due to a large amount of water content still stored in skin, by reducing the water content in the material it will increase the percentage of protein levels in treatments C and D, protein increases with reduced water content of skin, the longer the drying time, then the drying rate is greater and the water content is lower, the more solid material is dried, the drying rate is lower.

This is in accordance with the opinion of [7] the longer the drying time, the faster the evaporation occurs, so that the water content in foodstuffs is lower and [8] stated that the decreased water content will cause the protein content in the material to increase. The use of heat in food processing can reduce the percentage of water content which causes the percentage of protein content to increase. The drier an ingredient, the higher its protein content can consequently increase the nutritional value of karupuak jangek. In research [6], protein content of karupuak jangek are 63.90-64.71%, where is drying by using sunlight. The heat provided is not high, so protein levels can still be maintained.

By reducing the water content in food ingredients will contain compounds such as protein, carbohydrates, fats, and minerals in higher concentrations, but vitamins and dyes, in general, will be reduced. [9] stated that the longer the drying time, the water content will also decrease, this is also a supporting factor so that the protein content in each treatment is different because the longer the drying time will increase the protein content in the material.

3.2. Fat content

Based on research [6] from data in the case study in UKMK in West Sumatera have a fat content of 31.81-32.44%. This is because in addition to the value of fat content in the skin, it is also found in the frying process. High levels of fat in karupuak jangek contain a lot of triolein and diolein. In addition to the fat content that is already present in the karupuk, especially the effect of 2 times the karupuak frying with oil. Increased levels of deep fat karupuak jangek can be understood because karupuak have two times to fry eaten. As a result of this frying can cause trapping a number of oils in the pores of the skin. The average fat content of karupuak jangek in different drying time treatments can be seen in Table 2.

The results of the analysis (Table 2) showed that the influence of drying time on the quality of karupuak jangek with solar tunnel dryer had very significant influence ($P < 0.01$) on karupuak jangek fat content. The results of the further test with DMRT (Table 2), showed that treatment A gave a significantly different result ($P < 0.01$) to treatments C, D and B, treatments C and D had no significant

difference ($P > 0.05$) but significantly different with ($P < 0.01$) treatment B with higher fat content. As can be seen from the results of the study, the drying time of treatment A (drying time 1 days) gave the highest fat content of karupuk jangek of 17.14% and the lowest fat content in treatment D (drying time 4 days) with an average of 13.69%. The low-fat content in treatment B is due to the presence of water concentration in the material that is still stored in karupuk jangek. These results indicated that the longer the drying time, the fat content decreases. Research [6], fat content apart from the drying process is also influenced by the treatment after the crackers or karupuk are fried. In Aulia MSME, after frying, the oil in the crackers is drained for 3 hours, resulting in crispy. According to [10], skin fat content is inversely proportional to its protein content. Karupuk jangek with high-fat content usually have lower protein content. In this study, the long-time treatment of drying process of 1-4 days produces low-fat content, from this result it is suspected that the use of long drying time will be able to damage the fat composition of karupuk jangek. This is caused by fat oxidation. Fat oxidation reaction, one of which is influenced by water content in food. According to [11] water which plays a major role in the structure of food is also a major factor in fat oxidation. The decreased water content will increase the concentration of radical initiation and the level of contact between O_2 and fat causes fat to be damaged and in proportion will reduce the fat content of the material.

Table 2. Average fat content of karupuk jangek

Treatment	Average (%)
A	17.14 ^a
B	15.53 ^b
C	13.69 ^c
D	13.67 ^c
SE	0.47

Description: Superscript in the same column shows significant influence ($P < 0.01$). SE = Standard Error.

This is because the longer time in the drying process will increasingly cause a decrease in the value of fat content and inversely proportional to the protein content which increasingly shows an increase along with the long drying time and the increase in temperature used during the drying process. In line with the research of [12], which stated that with the length of time used in the drying process will cause the fat content in the material also decreases and the protein content increases.

In line with the research of [13], it was stated that decreasing fat content with high temperature/drying time could be caused by an increase in protein content so that the percentage of fat content decreased. Fat is a compound formed as a result of the esterification reaction between glycerol and fatty acids. Giving high heat to the fat will result in breaking of the double bonds in the fat so that the fat will be decomposed into glycerol and fatty acids. This is in accordance with the opinion of [14] that fat content is inversely proportional to water content, if the fat content is low then the water content is high, the fat will undergo hydrolysis or auto-oxidation that interacts with the protein. The higher the temperature, the higher the effect on physical and chemical changes in a material. Water content in raw karupuk jangek around 60.58-63.00% [6], certainly decreases during the drying process.

3.3. Texture test

Testing the texture by using a tool, saw increased the fragility of karupuk or crackers. Texture is affected by drying and frying processes [15]. According [16], that level the crispness of a cracker product is more influenced by the process drying, frying and packaging. The average texture of karupuk jangek in different drying time treatments can be seen in Table 3.

The results of the analysis (Table 3) showed that the influence of drying time on the quality of karupuk jangek with solar tunnel dryer gave a significantly different influence ($P < 0.05$) on the texture test on karupuk jangek. The results of further tests with DMRT (Table 3), treatment C and D C significantly different ($P < 0.05$) with treatments B and A for the higher texture test. An increase in the

texture test value in treatment D (227.04 N / cm²) due to the longer time the cowhide drying process will cause a decrease in the water concentration of cowhide. Treatment C and D, the texture value is high, because the crackers are dry and require great pressure with the texture analyser tool. In contrast to A and B, where the water content is still high, the needle texture analyser can easily penetrate the skin. This is caused by the water content in karupuak jangek which has been reduced optimally so that a dry and crispy texture is obtained for karupuak jangek. The karupuak jangek that fluffy will have a foam-like structure, if it is uneven, the crispness will be reduced because the top will become hard so that it affects consumers' preferences for the karupuak jangek. At a very high level of crispness, the texture of crackers will be rough, this roughness is related to the ability of crackers to form larger empty cells (air cells) when frying [17]. According to [11] water content and water activity have very big role, especially in determining the texture of food. [18] explained that the more unevaporated water during the frying process, this caused the fluffy level of crackers to be low and resulted in the low level of crispness. [19] added that the nature of cracker products is the ease of absorbing water (hygroscopicity), the easier and faster it absorbs water, the cracker products will be more easily sluggish so they are not crispy. According to [20], the empty space is contained in the tissue so that when crackers are fried causing crackers to become crispier.

Table 3. Average texture of karupuak jangek

Average	Treatment (N/cm ²)
A	132.84 ^b
B	163.60 ^b
C	210.92 ^a
D	227.04 ^a
SE	13.50

Description: Superscript in the same column shows significant influence (P<0.05). SE = Standard Error

3.4. Organoleptic test

3.4.1. *Colour.* According [21], the crackers are brownish colour is influenced by the strong acidic nature and the effect on the frying process. Drying time does not affect the colour of crackers. But in this study the drying time affects the colour of the crackers after frying. The average karupuak jangek colour in different drying time treatments can be seen in Table 4.

Table 4. Average organoleptic characteristic (colour) of karupuak jangek

Treatment	Average (scale hedonic)
A	2.22 ^a
B	2.19 ^a
C	2.06 ^b
D	2.09 ^b
SE	0.00

Description: Superscript in the same column shows significant influence (P<0.05). SE = Standard Error

The results of the analysis (Table 4) showed that the influence of drying time on the quality of karupuak jangek with solar tunnel dryer gave a significantly different influence on the karupuak jangek organoleptic test. The results of further tests with DMRT (Table 4), treatment A was not significantly different with treatment B but significantly different with treatment C and D on higher organoleptic values of colour. A scale of 2.06-2.22 means that the panellists quite like the colour of the crackers produced. We can see that the longer the drying time, the organoleptic value of colour decreases, this is caused by the oxidation of the pigments that exist in karupuak jangek. This is consistent with the opinion

of [22] that drying has several disadvantages such as changes in colour, texture, flavour, and aroma. Drying time that is too long and too high drying temperature can cause pigments in the material to oxidize, thereby blanching the pigment and can cause the material to burn (brown). And added by the results of [23] research, the quality of physical and organoleptic properties are affected by the boiling time and steaming time, which is best when boiled for more than 60 minutes at 90 °C and steamed for 6 hours at 120 °C.

3.4.2. Flavour. Based on research [6], the flavour that panellists prefer is savoury and crispy. The raw material for skin crackers also determines the flavour, which comes from cow leather, panellists prefer. For drying time in this study had no effect. The average karupuak jangek flavour in different drying time treatments can be seen in Table 5.

Table 5. Average organoleptic characteristic (flavour) of karupuak jangek

Treatment	Average (scale hedonic)
A	2.01
B	2.02
C	2.02
D	2.12
SE	0.00

Description: SE = Standard Error

The results of the analysis (Table 5) showed that the influence of drying time on the quality of karupuak jangek with solar tunnel dryer gave no significant influence on the organoleptic characteristic (flavour) of karupuak jangek. As can be seen in the results of the study with the longer drying time of until 4 days, can be accepted by panellists on a scale of 2.01-2.11 (quite like). The panellists used were semi-trained.

The addition of salt is performed to provide a savoury and salty flavour but also plays a role in inhibiting the growth of microorganisms [16]. [24] stated that the cause of an increase in the savoury of a food product is determined by the amount of protein and fat in the product. The higher fat contained in a product, the level of preference for the product will increase. That's because the fat gives a product a savoury and delicious flavour.

3.4.3. Texture. There were various texture characteristics described by the panellists, such as hard, crispy, and grainy texture. The panellist used were semi-trained. The assessment is based level of preference or hedonic. Panellists could not distinguish the drying time after the karupuak jangek were fried. The average karupuak jangek texture in different drying time treatments can be seen in Table 6.

Table 6. Average organoleptic characteristic (texture) of karupuak jangek

Treatment	Average (scale hedonic)
A	2.09
B	2.10
C	2.12
D	2.13
SE	0.00

The results of the analysis (Table 6) showed the influence of drying time on the quality of karupuak jangek with solar tunnel dryer gave no significantly different influence on the organoleptic characteristic (texture) test of karupuak jangek. The karupuak jangek that fluffy will have a foam-like structure, if it is uneven, the crispness will be reduced because the top will become hard so that it affects consumers' preferences for the karupuak jangek. Added by the opinion that at a very high level of crispness, the

texture of crackers will be rough, this roughness is related to the ability of crackers to form larger empty cells (air cells) when frying [20].

[6] argued that crispness is an important factor in the acceptance of frying products such as crackers. The dry texture of the frying results depends on the ease of breaking of the constituent particles at the time of mastication and also depends on the size and firmness of the already developing starch granules. [15] stated that texture is most important in soft foods and crispy foods. The characteristic most often referred to is crispness, cohesiveness, and water content. There are three classes of texture characteristics, namely mechanical, geometric and other characteristics related to water and fat.

4. Conclusion

The results of the study showed that drying time 3 days gave the highest results on protein content, fat content, texture test, and organoleptic test. Protein content in treatment C with an average of 58.88% and fat content with an average of 13.694%, texture test 210.92 (N/cm²), organoleptic tests on colour with an average of 2.06, on flavour with an average of 2.02 and on texture with an average 2.12 showed quite like. To carry out further research on drying using a solar tunnel dryer it is recommended that drying is carried out for 3 days.

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