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EXPERIMENTAL RESULTS OF CURD CUTTING EQUIPMENT

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ABSTRACT

In order to cut the curd prepared in the traditional way in a short time and evenly, a curd cutting device was developed and the distance between the wires of the device was determined depending on the shrinkage coefficient of the curd. The cow's milk of a herder household in Tuv aimag is processed in the traditional way, yoghurt is prepared, the curd is placed on a yam cloth and pumped to a moisture content of 60%. Samples with the same amount of cut curd were dried in a desiccator at 50 ° C for 10 h and the weight and moisture content were determined every hour. As a result of the drying test, the weight of the curd stabilized after 7 hours, and the moisture content reached 20%, reaching the standard value. The linear size of the curds sampled after drying decreased by 16 to 23 percent and the linear shrinkage coefficient of the curds was 0.0274.

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Introduction.

Mongolians have a long history of knowledge and developing to process the milk of their livestocks in accordance with the characteristics of natural and climatic conditions. Mongolians make many different types of dairy products from the milk such as aaruul (dried curd), khuruud and eezgii (Indra 2002). Traditional Mongolian dairy products are consumed not only as important energy sources, but as traditional medicines (Takeda et al. 2013; Won-Young Cho, Go-Eun Hong, Ha-Jung Lee, Su-Jung Yeon, Hyun-Dong Paik 2020). Dried curd (Aaruul) is made of curdled milk that has been air-dried in direct sunlight. It is consumed as a snack, is sometimes flavored with sugar and berries, and has a long shelf-life which is perfectly suited to the nomadic lifestyle (Daginder 2015). Curd is a world-renowned product due to its special health and biological significance (Damdinsuren 2002).

Mongolians produce raw curd in three different ways. These include:

1. Curd from vodka distillation
2. Curd from yogurt
3. Curd produced by enzyme-acid technology.

Traditional curds are made from vodka distillation curd and the yogurt curds, and the basis of the technology of curd production is explained by the theory of thermal acid fermentation. There are the two main methods on thermal acid fermentation. The first one is – heat milk temperature up to 85-90^{0}C, make the yogurt pH to 4.7-5.0 by the acidic yogurt or whey milk to turn the milk into curd, and

the second one is – to boil the acidic fermented milk and take out the protein by filtering. The filtered curd needs to be dried after pressing and cutting. These operations are interdependent processes and take a total of 4 to 5 days (Amgalanzul and Baatarkhuu 2021).

In order to increase the efficiency of compression (filter-pressing) and save time a curd compression device was designed to determine curd moisture based on curd weight, pressing pressure, and time, and to determine their optimal values (Amgalanzul and Baatarkhuu 2021). The optimal values of the inlet parameters of the curd filter pressing process are calculated as 2 kg of curd weight, 5 kg cm-2 (0.49 MPa) of pressing pressure and 3 hours of pressing time to be 59% of the curd moisture content. The moisture content of the curd is 59%, which meets the requirement for moisture content of protein dairy products.

Figure 1 shows the correlation of the curd moisture (y) from the curd weight (X_1) and the pressure of the pressed curd.

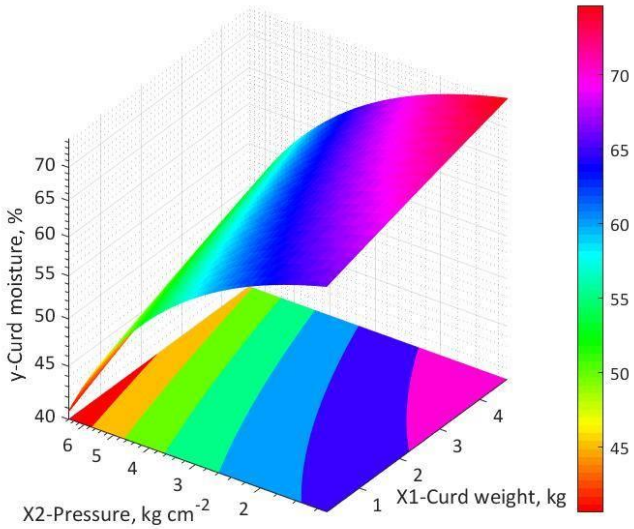

Fig. 1. The moisture reflecting surface of pressed curd and its correlation graph y=f(X_1, X_2)

It shows that when the pressure (X_2) increases, the curd moisture (y) declines, when the curd weight (X_1) rises, the curd moisture (y) increases, respectively. The maximum value of the pressure (X_2) and the minimum value of the curd weight (X_1) can be seen in Figure 5 to hold the curd moisture (y) at between 55 – 60%.

Simplification of milk processing by herder households and farmers, especially curd pressing and cutting in a short time, will make a real contribution to increasing the production and consumption of dairy products, selling them on the market will be the increasing profits, and developing household businesses.

Research materials and methodology.

We used yogurt curd in the experiment (Damdinsuren 2014) and performed the test according to the following scheme.

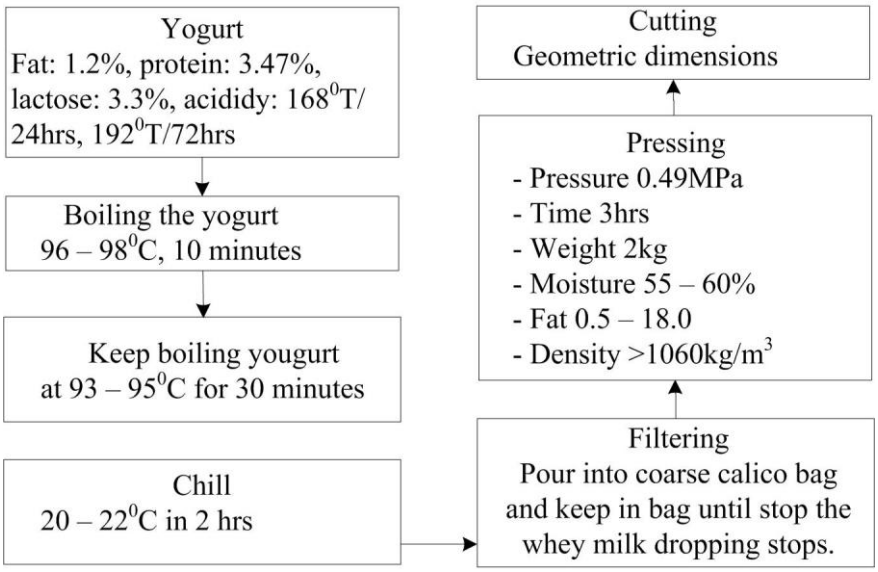

Fig. 2. Technological scheme of aaruul making traditional method

The curd prepared by the traditional method is pressed with a compression device to a moisture content of 60%. The filter-pressed curd cut by same distanced caliper of the sewing thread, and 19 samples were prepared for drying process.

Fig. 3. Photo of the samples of filter-pressed and cut curds

The average geometric size of the samples was 3.95 cm long; width 2.57 cm; and the thickness was 1.58 cm. 6 samples are dried on tray with other curds; and at 50°C in a drying oven. The weight of the samples was measured in every one hour on the electronic balance G&G 0512 - 52671954 with an accuracy of 0.01g.

Fig. 4. Photo of measuring of the aaruul weight

Mathematical and statistical processing of the measured values was performed to verify that whether the over-emission variables are governed by the laws of normal distribution (Avdai and Enkhtuya 2019).

Results of the research.

The values of the measurements before and after drying of the samples are shown in Table 1.

Table 1. The comparative weights after the drying process

Sample number	Initial	After	Initial	After	Initial	After
	Length [cm]		Wide [cm]		Thickness [cm]	
1	4	3.2	2.5	2.1	1.7	1.3
2	4	3.2	2.7	2.3	1.7	1.3
3	3.9	3.1	2.5	2	1.6	1.3
4	3.8	3	2.6	2.1	1.7	1.2
5	3.8	3	2.6	2.2	1.6	1.2
6	3.9	3	2.7	2.25	1.6	1.2
7	4	2.9	2.7	2.25	1.6	1.2
8	4.1	3.2	2.3	1.95	1.5	1.2
9	3.75	3.15	2.6	2.2	1.5	1.1
10	4	3.15	2.6	2.3	1.45	1.1
11	4.1	3.25	2.3	2.1	1.5	1.2
12	3.8	2.95	2.7	2.2	1.5	1.2
13	4	3.05	2.7	2.25	1.5	1.15
14	3.7	2.95	2.6	2.2	1.6	1.3
15	4.1	3.3	2.4	2.1	1.5	1.25
16	4.1	3.25	2.3	2	1.7	1.25
17	4	3.3	2.7	2.1	1.6	1.25
18	4.1	3.2	2.8	2.3	1.5	1.2
Arithmetic mean	3.95	3.12	2.57	2.16	1.58	1.22
Dispersions	0.02	0.02	0.02	0.01	0.01	0.00
Square mean or standard deviation	0.13	0.13	0.16	0.11	0.08	0.06
Coefficient of variation	3.37	4.12	6.08	5.05	5.36	5.08
Mean value error	0.03	0.06	0.16	0.07	0.12	0.05
Average square deviation error	0.80	2.03	6.41	3.02	7.58	4.15
Calculated value of the Shapiro and Wilk's criteria $\boldsymbol{W}_{\text{T}}$	253.2	267.5	251.2	264.4	244	254.9

For mathematical statistical processing of the measured values, the variation coefficients are being V = 3.37-6.08, which proves that the size of the curd is uniform and homogeneous.

But the minimum value of the length dimension was subtracted from the measured values. So, the number of samples was reduced to 18, for the further performed calculations.

To test compliance with the law of normal distribution by Shapiro and Wilka's W test, the calculated value is determined by the following formula.

Calculated value of the criteria

$$\boldsymbol{W_T = \frac{Q^2(m-1)}{\sigma_x^2}} \quad (1)$$

The calculated value was m=18 at $W_T = 244 - 283$, and the probability level at P = 0.95 the W_x was equal to 0.897. Therefore, Shapiro and Wilka's W test is satisfied and that the measured values are governed by the law of normal distribution.

The weight of the dried curd in the drying device was measured at every one hour and the following graph was constructed as a result.

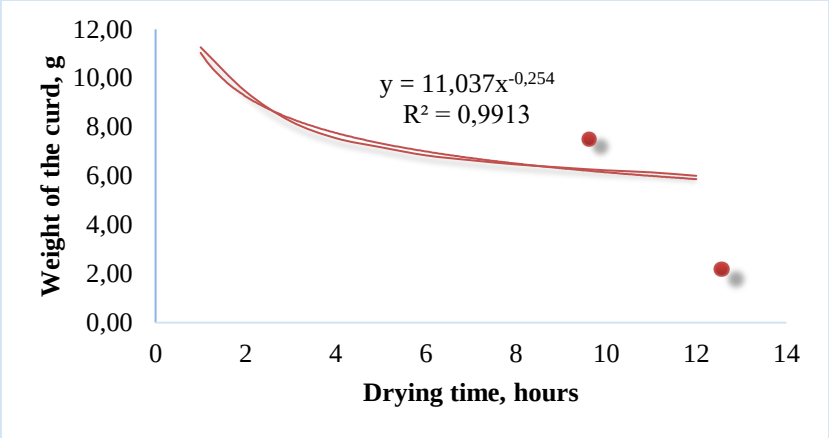

Fig. 5. The graph of aaruul weight dependence from the drying time

The graph shows that the weight of curds decreased from 11.26g to 6.01g, and 46.7% of the weight was lost.

The following graph shows the dried curd and its moisture content.

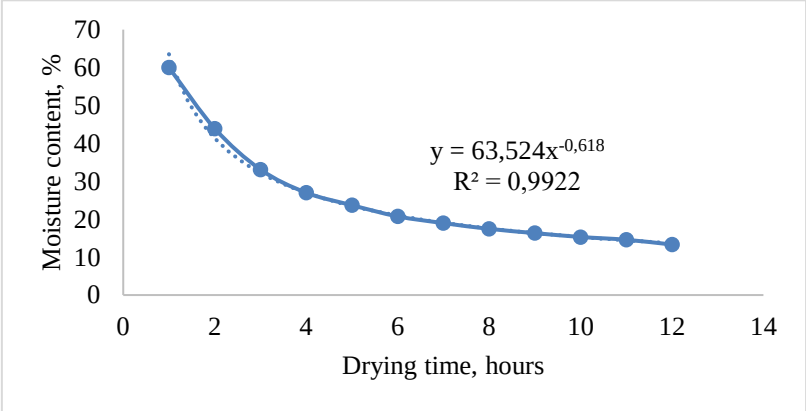

Fig. 6. Moisture content dependence graph from drying time duration

General technical requirements for protein dairy products MNS 4230: 2005 standard specifies the moisture content of curd must be as 10 - 20% (Standards of general technical requirements for protein dairy. MNS 4230:2005 2005). The moisture of the curd decreases to 20% after 7 hours after dried at 50°C.

The geometric dimensions of the cut curd during drying and standard moisture values were determined and shown in Table 2.

Table 2. Geometric dimensions of the curd cutting

	Aaruul	Curd	Aaruul	Curd	Aaruul	Curd	Aaruul	Curd	Aaruul	Curd
Length [mm]	150	182	100	121	100	121	70	85	50	61
Wide [mm]	50	58	77	81	50	58	50	58	50	58
Thickness [mm]	10	12	10	12	10	12	10	12	5	6

Based on the dimensions given in the table above, it is possible to select the distance between the wires of the curd cutting device and make a design. For example, to make a 15:5:1 cm aaruul, the curd cutter spaces should be spaced 18:6:1.2 cm apart.

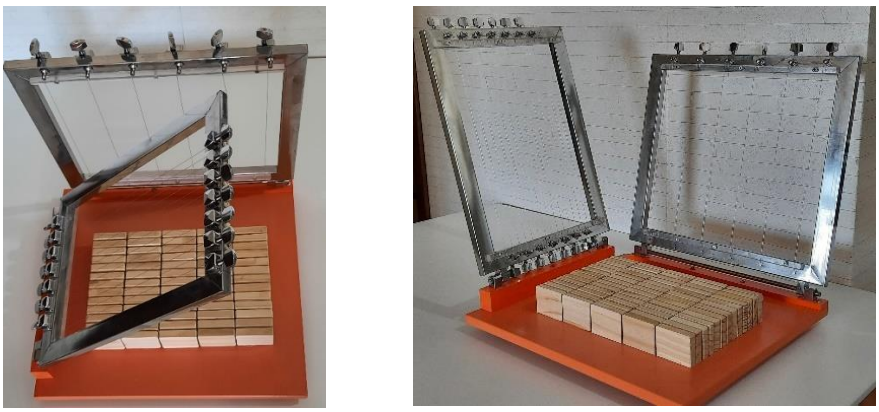

Fig. 7. Curd cutting device

Conclusions.

- As a result of the drying test, the weight of the curd stabilized after 7 hours and the moisture content reached the standard value and decreased to 20%.
- After drying, the linear size of the curd represented by the sample decreased by 16 to 23 percent and the coefficient of linear shrinkage of the curd was determined to be 0.0274.
- The distance between the wires of the rectangular curd cutting device, which is 5 cm long and 1.2 cm thick, is defined as 6.2 cm and 1.5 cm.

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