The influence of coagulants and cooking period on the quality of *dali ni horbo*

M B Pratiwi, H Sinaga* and E Julianti

Department of Food Science and Technology, Universitas Sumatera Utara, Medan, North Sumatera, Indonesia

E-mail: *hotnida.sinaga@uq.net.au

**Abstract.** The purpose of this research was to determine the effect of coagulants and cooking period on the quality of *dali ni horbo*. This research was using group randomized design with two factors, such as: coagulants (G): (pineapple juice, lime juice, lemon juice, belimbing wuluh fruit) and cooking period (M): (40, 50 and 60 minutes). The results showed that the coagulants and cooking period gave a very significantly different effect (P<0.01) on pH, moisture and protein contents of the *dali ni horbo*, but had no significant different effect (P>0.05) on the ash content. Furthermore, the interaction of factors resulted in a significant different effect (P<0.05) on the ash and protein contents. The coagulants decreased the moisture and protein contents of *dali ni horbo* and increased the pH and ash contents of the products. Based on parameters protein, moisture, ash contents and pH, it was found that the best treatment was *dali ni horbo* coagulated with lime juice for 40 min.

1. **Introduction**

Indonesia is a country that has cultural varieties between each region. Every region has its special culture and traditional food that can be introduced to the public outside the region. North Sumatra has a variety of typical foods including *dali ni horbo*, naniura, arsik, gomak noodles, mashed sweet potato leaves and many others. However, the traditional products has begun to be forgotten by its own people, so that the characteristic of each region might be extinct and not known by the new generations.

*Dali ni horbo* is a typical food of Toba, Samosir, North Sumatra. The texture is similar to tofu and made from buffalo milk as a basic ingredient. *Dali ni horbo* might be related to other traditional foods from West Sumatra (dadih) and from South Sulawesi (dangke) [1]. Dangke, named is enrekang cheese is a traditional food of South Sulawesi, which is made by coagulating cow milk using papaya sap. Papaya sap contains sulfhydryl proteinase enzyme which functions as a catalyst for biological reactions. This protease enzyme naturally converts milk into clots due to the separation of protein and water. Use of low heat and high heat can be applied to inactivate the enzyme activity and to help the differences in their effects [2-3]. In addition to papaya sap, pineapple juice can also be used as a coagulation material [4]. Dadih is one of traditional food from West Sumatera. This made naturally by fermentation at room temperature for 48 hours. Processing of curd generally uses buffalo milk through natural fermentation by utilizing lactic acid bacteria [5].
Dali ni horbo is made by mixing coagulation agents into fresh buffalo milk. Milk coagulation of casein can be done by natural agents that contain citric acid and proteolytic enzymes such as lime (Citrus aurantifolia) [6], belimbing wuluh fruit (Averrhoa belimbi) [7], papaya (Carica papaya) and pineapple (Ananassativus) [8]. One of the characteristic of milk is that it can coagulated caused by addition acid. Coagulant with acid is controlled by pH, clumping of casein particles is located at an isoelectric point that is at pH 4.6. Particle activity in water experiences decrease in the isoelectric point by because of that there will be clumping and addition of acid will coagulate milk protein, especially casein and a little albumin. Lowering the pH to the isoelectric pH (around 4.6) causes the clusters become denser, form a more compact structure and eventually start to gel [9-10].

There are so many benefits of using the variety fruits as raw materials for the coagulants. The fruits are always available and harvested throughout the year. In addition, they also spread around Indonesia and can be bought at low cost, so that they are easily used all the time [11]. The fruit has high vitamins and minerals contents and beneficial for health. Such as like healing sprue, arthritis and so on.

Although dali ni horbo has been consumed for many years, there was only limited research on products. Previous research on dali ni horbo is the effect of adding rimbang (Solonumtorum Swartz) fruit juice to the quality of dali ni horbo. The best result obtained is the addition of rimbang fruit juice as much as 15% of the volume of buffalo milk used is 500 ml. Rimbang fruit contains succinic acid which has similar characteristic to the enzyme papain [12]. But a lot of research has been done on dadih from West Sumatra. For example like the quality of goat milk dadih incubated in various types of bamboo. Bamboo ori gave the best result in quality of dadih [13].

The coagulants play an important role for solidifying the milk, therefore, research on the best and alternate clotting agents will provide much information on the quality of dali ni horbo. The finding results are expected to help people to choose the clotting agents which can also be combined with the availability of the plants grown in that areas. Similarly, cooking period might affect the clumping and clot hardness, so that the reliable period can produce good final result quality, save time and cost production. Hence, the purpose of this research was to determine the effect of coagulation agents and cooking period on the quality of dali ni horbo.

2. Materials and methods
The materials used in this study was buffalo milk obtained from farm fresh cow and buffalo milk in Asam Kumbang, Medan, North Sumatra. Fresh pineapple, mature lime, mature lemon and mature belimbing wuluh fruit were obtained from traditional market in Medan, North Sumatra. Reagents used in this study were H2SO4, NaOH and aquadest.

2.1 Making of pineapple juice
Pineapple fruit was sorted, peeled and then washed. The pineapple size was reduced and then was combined with water by comparison 1:2 using blender. Pineapple juice was obtained by filtering the blended mixture using a sterile filter cloth.

2.2 Making of lime and lemon juice
Lime and lemon juice were obtained by firstly sorted and washed the fruits. After cutting into two parts, the lime and lemon were squeezed by using a squeeze device. The resulted product was then filtered using a sterile filter cloth.

2.3 Making of belimbing wuluh juice
Belimbing wuluh fruit is sorted, washed and blended with water with a ratio of 1:0.5. Then, the mixture was filtered to obtain belimbing wuluh fruit juice.

2.4 Making dali ni horbo
Buffalo milk was pasteurized at 63°C for 30 minutes. Then, each 300 ml of the pasteurized milk was taken and put into a 500 ml glass beaker. Afterwards, 5% of pineapple juice, 5% of lime juice, 5% of
lemon juice and 30% of belimbing wuluh juice were added to the mixture of milk and heated until the temperature reached 50°C. The heating or cooking process was undertaken for 40, 50 and 60 min. The mixtures were filtered after the addition of 4 g salt.

2.5 Data analysis

This study used a group randomized factorial design with 2 factors. The first were coagulants (G): G1 = pineapple juice, G2 = lime juice, G3 = lemon juice and G4 = belimbing wuluh juice. And the second factors were cooking period (M): M1 = 40 min, M2 = 50 min and M3 = 60 min. Each treatment was made in 3 replications so the total sample size was 36 samples. The data obtained were processed using variance analysis (ANOVA). Significant treatments were tested further using the LSR (Least Significant Range) test. Parameters analysed were pH, moisture, ash and protein contents.

3. Results and Discussions

3.1 pH

It can be seen in Figure 1 (A) that the types of coagulants had a significant effect (P<0.01) on the moisture content of dali ni horbo. The highest pH content of (4.81) was resulted from products made of pineapple juice (G1) and dali ni horbo made from belimbing wuluh juice (G4) had the lowest pH content (4.51). The higher the concentration of citric acid used, decreasing the pH value [14]. Similarly, cooking period had also given a significant effect (P<0.01) on the pH content of dali ni horbo. Figure 1 (B) shows that cooking the product for 60 min (M3) resulted in higher pH content (4.78) compared to the product with faster cooking period. The effect of longer cooking period causes the loss of some heat-volatile substances such as organic acid, that is citric acid [15].

Note: Different notations show significantly different effects at the 5% (lower case) and 1% very real difference (upper case)

Figure 1. pH of dali ni horbo as a function of coagulants (A) and cooking period (B). G1 = pineapple juice, G2 = lime juice, G3 = lemon juice and G4 = belimbing wuluh juice

3.2 Moisture content

It can be seen in Figure 2 (A) that the types of coagulants had a significant effect (P<0.01) on the moisture content of dali ni horbo. The highest moisture content of (64.38%) was resulted from products made of pineapple juice (G1) and dali ni horbo made from belimbing wuluh juice (G4) had the lowest moisture content (61.18%). The difference in moisture content caused by the use of acid coagulants in the manufacture of food products has a different pH. Food products with the lowest pH or in more acidic conditions will lose the most water, therefore it has the lowest moisture content [16].
Similarly, cooking period had also given a significant effect (P<0.01) on the moisture content of *dali ni horbo*. Figure 2 (B) shows that cooking the product for 40 min (M₁) resulted in higher moisture content (64.08%) compared to the product with longer cooking period. Other research also reported the moisture content increase with prolong cooking, because the heating may cause evaporation of water. Therefore, longer cooking period is leading to the lower moisture content [17].

![Figure 2](image)

**Figure 2.** Moisture content of *dali ni horbo* as a function of coagulants (A) and cooking period (B). G₁ = pineapple juice, G₂ = lime juice, G₃ = lemon juice and G₄ = belimbing wuluh juice.

### 3.3 Ash content

It can be seen in Figure 3 (A) that the types of cooking period had a significant effect (P<0.01) on the ash content of *dali ni horbo*. The highest ash content of (3.35%) was resulted from products made of 60 min (M₃) and *dali ni horbo* made from 40 min (M₁) had the lowest ash content (1.53%). Heating for a long time will cause the products moisture content decrease to increase mineral concentration [18].

Similarly, the interaction had a significant effect (P<0.05) on the ash content of *dali ni horbo*. Figure 3 (B) shows that cooking the product for 60 min (M₃) resulted in higher ash content compared to the product with faster cooking period. Acid solution can hydrolyse the mineral content in food products so that it can affect ash content in food products [19]. And also heating for a long time will cause the products moisture content decrease to increase mineral concentration.

![Figure 3](image)

**Figure 3.** Ash content of *dali ni horbo* as a function of cooking period (A) and interaction (B). G₁ = pineapple juice, G₂ = lime juice, G₃ = lemon juice and G₄ = belimbing wuluh juice.
3.4 Protein content

It can be seen in figure 4 (A) that the types of coagulants had a significant effect (P<0.01) on the protein content of dali ni horbo. The highest protein content of (4.81%) was resulted from products made of lime juice (G3) and dali ni horbo made from belimbing wuluh juice (G4) had the lowest protein content (4.11%). One of the factors that influence denatured proteins is acidification or coagulation so milk contains protein in the form of casein which can be clumped with the addition of acidification ingredients [15].

Cooking period had also given a significant effect (P<0.01) on the protein content of dali ni horbo. Figure 4 (B) shows that cooking the product for 40 min (M1) resulted in higher protein content (4.78%) compared to the product with longer cooking period. Processing milk by heating can cause a decrease in the nutritional value of milk. During the process of heating high-temperature milk to the boiling point, it can cause changes to the content of milk nutrients such as caramelization, protein clotting and discoloration of dairy products [20].

Similarly, the interaction had a significant effect (P<0.05) on the protein content of dali ni horbo. Figure 4 (C) shows that cooking the product for 40 min (M1) resulted in higher protein content compared to the product with longer cooking period.

Note: Different notations show significantly different effects at the 5% (lower case) and 1% very real difference (upper case).

Figure 4. Protein content of dali ni horbo as a function of coagulants (A), cooking period (B) and interaction (C). G1 = pineapple juice, G2 = lime juice, G3 = lemon juice and G4 = belimbing wuluh juice.
4. Conclusion
The types of coagulants has a very significant different effect on pH, moisture and protein contents, but gave no significant effect on the ash content. However, cooking period affected all measured parameters such as pH, moisture, ash and protein contents. The interaction of both treatments significantly affected the ash and protein contents. The finding research provide benefits for community, as they can make *dali ni horbo* with raw material that are easy to find in their surrounding areas. It is suggested that further study is needed to improve the shelf life of *dali ni horbo*.

References
[1] Muhammad Z 2002 Upaya peningkatan produksi susu kerbau bagi ketersediaan dan mempertahankan potensi dadih (Efforts to increase buffalo milk production for availability and maintain the potential of curd). Proc. National Seminar on Animal Husbandry and Veterinary Technology (Ciawi-Bogor) pp 186–9
[2] Hotnida S, Nidhi B and Bhesh B 2016 Partial renneting of pasteurised bovine milk: casein micelle size, heat and storage stability Food Research International 84 pp 52–60
[3] Hotnida S, Nidhi B and Bhesh B 2017 Gelation properties of partially renneted milk Int. J. of Food Properties 20 pp 1700–14
[4] Nurliyani 2012 Penanganan dan Pengolahan Susu Secara Sederhana (Simple Handling and Processing of Milk) (Yogyakarta: PT. Citra Aji Parama)
[5] Afriani, Suryono and Lukman H 2011 Karakteristik dadih susu sapi hasil fermentasi beberapa starter bakteri asam laktat yang diisolasi dari dadih asal Kabupaten Kerinci (Characteristics of fermented cow milk curd from several starters of lactic acid bacteria isolated from curd from Kerinci district) Jurnal Agrinak 1 pp 36–42
[6] Shanaziya A S F, Mangalika U L P and Nayananjalie W A D 2018 Effect of different coagulants on the quality of paneer made from cow milk Int. J. of Scientific and Research Publications 8 pp 189–94
[7] Fitri S, Fajar R and Ahmad I 2017 Potensi ekstrak kasar enzim bromelin pada bonggol nanas (*Ananas comosus*) sebagai koagulan alami lateks (*Hevea brasiliensis*) (Potential bromelin enzyme crude extract in pineapple hump (*Ananas comosus*) as natural latex coagulant (*Hevea brasiliensis*) Jom Faperta 1 pp 1–13
[8] Nur A B 2013 Isolation and utilization of bromelain enzyme from pineapple fruit (*Ananas comosus* (l) merr) for making soft cheese Proc. Int. On 1st Annual Scholars Conference (Taiwan)
[9] Hotnida S, Nidhi B and Bhesh B 2017 Effect of milk pH alteration on casein micelle size and gelation properties of milk Int. J. of Food Properties 20 pp 179–97
[10] Nurhidajah and Agus S 2012 Kadar kalsium dan sifat organoleptik tahu susu dengan variasi jenis bahan penggumpal (Calcium content and organoleptic properties of milk tofu with various types of coagulation ingredients) Jurnal Pangan dan Gizi 3 pp 39–48
[11] Indri F D, R Singgih S S and Samsu W 2013 Pengaruh waktu perebusan dan tingkat pemberian papain komersial terhadap kadar protein dan organoleptik tahu susu (The effect of boiling time and the level of commercial papain on milk protein and organoleptic levels) Jurnal Ilmu Peternakan 1 pp 842–7
[12] Andrew S L, Elisa J and Rona J N 2017 Pengaruh penambahan sari buah rimbang (*Solonumtorvum* Swartz) terhadap mutu makanan tradisional khas batak *dali ni horbo* (The effect of adding rimbang fruit juice (*Solonumtorvum* Swartz) to the quality of traditional foods of Batak dali ni Horbo) Proc. Seminar National on Innovation in Food and Agricultural Products
[13] Meinar D S W, Imam T and Purwadi 2016 Kualitas dadih susu kambing yang diinkubasi pada berbagai macam bambu (The quality of goat milk curd is incubated on various types of bamboo) Jurnal Ilmu dan Teknologi Hasil Ternak 11 pp 22–37
[14] Nur H F, Nur H R P and Godras M 2017 Pengaruh konsentrasi asam sitrat dan suhu pengerengan terhadap karakteristik fisik, kimia, dan sensorik dari manisan kering chayote (Sechium edule Sw) dengan penggunaan pewarna alami dari ekstrak roselle ungu (Hibiscus sabdariffa L.) (Effect of citric acid concentration and drying temperature on physical, chemical and sensory characteristics of dried candied chayote (Sechium edule Sw) with the use of natural dyes from extract of purple roselle (Hibiscus sabdariffa L.)) *Jurnal Agroteknologi* **10** pp 50–66

[15] Rahayu R and Yunianta 2015 Pengaruh proporsi buah : air dan waktu pemansan pada aktivitas antioksidan jus buah kedondong (Spondias dulcis) [Effect of proportion of fruit: water and cooking time on the antioxidant activity of kedondong fruit juice (dulcis conditioner)] *Jurnal Pangan dan Ilmu Pertanian* **3** pp 1682–93

[16] Muhammad A, Eka W and Hartati C 2015 Karakteristik kadar air dan protein serta organoleptik dari keju segar dengan penggunaan jeruk nipis, jeruk lemon, dan asam sitrat sebagai bahan penggumpal (Characteristics of water and protein contents and organoleptic from fresh cheese with the use of lime, lemon and citric acid as coagulation ingredients) *Jurnal Ilmiah Mahasiswa* **1** pp 1–14

[17] Ovrida W N, Wahono H S and Jaya M M 2017 Pengaruh suhu dan waktu pemasakan terhadap karakteristik lempok labu kuning (Effect of temperature and cooking time on the characteristics of lempok pumpkin) *Jurnal Pangan dan Agroindustri* **5** pp 15–26

[18] Melva S P, Zulkifli L and Ridwansyah 2017 Pengaruh perbandingan konsentrasi xanthan gum dengan karagenan dan lama pemasakan terhadap mutu jelly terong belanda (Effect of the ratio of xanthan gum concentration to carrageenan and the length of cooking to the quality of dutch eggplant jelly) *Jurnal Rekayasa Pangan dan Pertanian* **5** pp 717–723

[19] Dian F S and Vanessa N J L 2015 Pengaruh konsentrasi asam asetat terhadap karakteristik fisikokimia tepung ikan dari daging merah ikan tuna (Effect of acetic acid concentration on physicochemical characteristics of fish meal from tuna red meat) *Jurnal Ilmiah Agribisnis dan Perikanan* **8** pp 1–8

[20] Habibah and Yunizar R 2012 Perubahan kadar protein dan pH susu pasteurisasi selama penyimpanan dingin (Changes in protein levels and pH of pasteurized milk during cold storage) *Jurnal Agroscientiae* **19** pp 11–15