

Milk Processing System in Rwanda

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Abstract

The purpose of this paper is to 1) understand milk processing system in Rwanda through a field survey, and 2) identify characteristics of milk processing techniques in Rwanda. The milk processing system in Rwanda used the no heating/lactic acid fermentation from the fermentation processes, in which raw milk is used without pasteurizing by heating, and naturally fermented by the naturally mixing microbial flora. The characteristics of milk processing technique in Rwanda is that they adopted the milk fat separation and preservation techniques to make butter from raw milk, but they did not develop the milk protein separation and preservation techniques to make cheese. The year-round breeding and the constant supply of raw milk seem to be the reason why agro-pastoralists did not need to fractionate and preserve milk protein from raw milk and buttermilk. Since they do not make cheeses in Rwanda, the diet system in which they take naturally fermented milk and buttermilk developed inevitably. The characteristics of milk fat separation and preservation techniques in Rwanda is that the final form of milk fat is butter, because Rwanda is located in the highlands where it is relatively cold condition throughout the year. It was thought that the people of Rwanda regard butter on the basis of its strength of flavor and how much it can improve the taste when added to dishes rather than its shelf life. It can be said that the African inland regions in the highlands near the equator have developed a very unique milk culture.

Key words: milk processing technique, cool, highland, food culture

Introduction

Milking and milk processing originated in West Asia, giving rise to a new subsistence of pastoralism that relies on milk culture^{1~5}). Pastoralism that is accompanied by milking and milk processing is thought to have transmitted from West Asia to the surrounding regions when its milk processing technique has developed to be able to preserve milk⁶). Many systematic studies relating to milk processing techniques were carried out on the Eurasian continent in each region of West Asia, Central Asia, North Asia, South Asia, and Europe. Based on these numerous case studies, the author hypo-

thesized the history of milk processing on the Eurasian continent in which the milk processing technique developed the fermentation processes in West Asia and then transmitted to the surrounding areas, where it developed into the northern milk cultural sphere and the southern milk cultural sphere⁶).

There are still few case studies, which provide a full picture of the milk processing techniques in each African region^{7~11}) and no one has yet to anthropogeographically analyze the characteristics of the milk processing techniques on the African continent. The author has conducted researches in Kenya and Ethiopia to identify the characteristics of milk processing techniques in East African regions^{6,8}). Rwanda is located at the western end of East African region and at the southern end of the milk cultural sphere extending out from West Asia¹²). Rwanda is in a very important position to be able to identify the characteristics of East African milk culture and to study the transmission

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August 1, 2018 received
October 4, 2018 accepted
[doi:10.11465/milk.67.175]

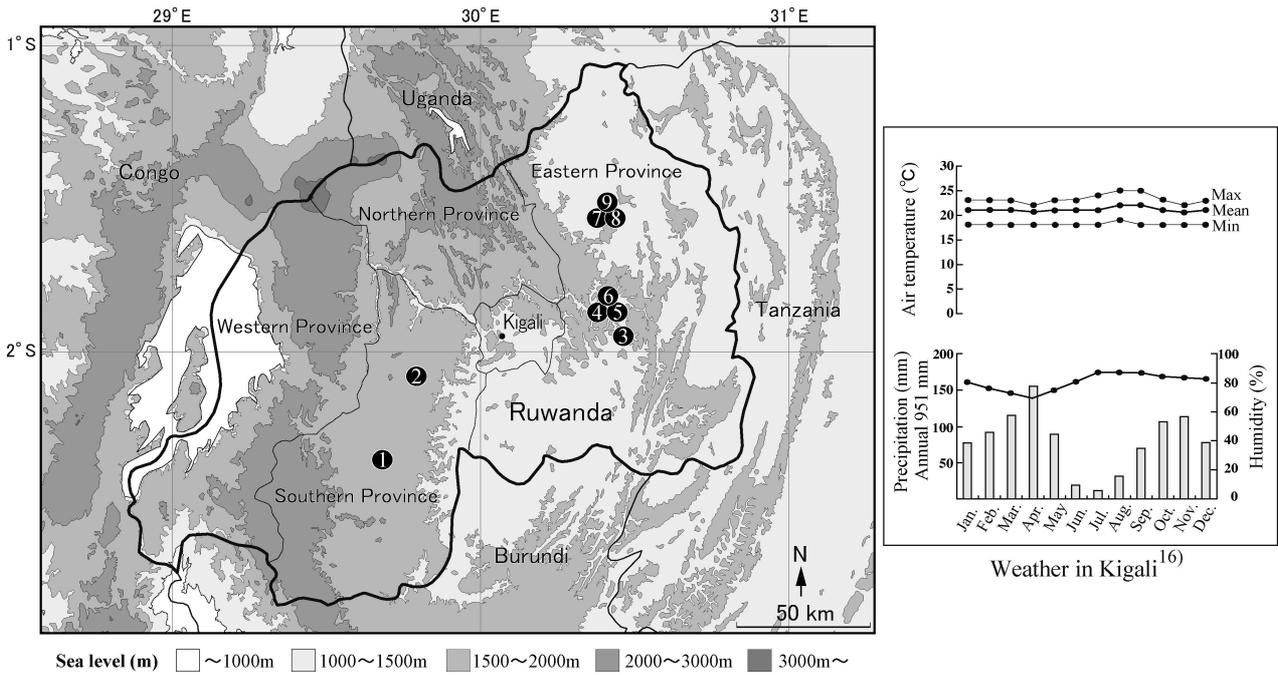


Fig. 1 Survey sites (①~⑨) in the highlands of Rwanda

of milk culture from West Asia to the African continent, but there has not been enough study on the milk processing system in Rwanda¹³⁾. Hence, the purpose of this paper is to 1) understand the milk processing system in Rwanda through a field survey, and 2) identify the characteristics of milk processing techniques in Rwanda.

Materials and Methods

1. Natural environment

Rwanda is located inland of the African continent near the equator. Ruzizi River in southwestern Rwanda is at the lowest altitude at 950 m above sea level, and Mount Karisimbi in northwestern Rwanda is at the highest altitude at 4,507 m above sea level. Rwanda is located in the highlands as most of eastern Rwanda is above 1,000 m above sea level and most of western Rwanda is above 1,500 m above sea level (Fig. 1). Much of Rwanda's terrain is made up of rolling hills and valleys¹⁴⁾.

As Rwanda is located near the equator, the temperature is stable throughout the year. In the capital city of Kigali, at about 1,500 m above sea level, it is warm throughout the year with an average monthly temperature of about 22°C. The

average lowest monthly temperature is about 17°C and the average highest monthly temperature is only about 24°C, with the temperature decreasing as altitude rises. As described above, Rwanda experiences a cold to warm climate¹³⁾. Rwanda's traditional houses are often made of tall grasses and mud walls and its structure allows for a good ventilation¹⁵⁾. It can almost feel chilly inside the house. The rainy season is from September to May, and the dry season is from June to August, but it rains throughout the year¹⁶⁾. The annual rainfall in Kigali is 951 mm and crops can be cultivated with rain water. The climate in Rwanda can be characterized as warm and humid throughout the year while the indoor environment is relatively cool.

2. Research methods and research households

The field survey was conducted on a total of nine households in Rwanda in March 2018. The author interviewed the homemakers who process milk about the milk processing techniques and observed the milk processing. The surveyed households were selected at random from all over Rwanda. The surveyed households were all from the social class of Hutu/Tutsi belonging to the Bantu ethnic group who are agro-pastoralists that raised

livestock while cultivating crops. The interviews were conducted in Kinyarwanda, the official language of Rwanda, and notated in English alphabet.

The analysis of milk processing system in this paper was analyzed according to the Nakao's model used to categorize and organize the world's milk processing techniques¹⁷⁾. Nakao categorized the world's milk processing techniques into the following four types: 1) Fermentation processes, which start out by making sour milk from raw milk, 2) Cream separation processes, which start out by separating cream from raw milk, 3) Additive coagulation processes, which involve adding a coagulant to raw milk to make cheese, and 4) Heat condensation processes, which are based on heating and condensing raw milk.

Household 1 is from Busasamana sector (*umurenge*), Nyanza district (*akarere*), Southern province (*intara*), household 2 is from Musanbira sector, Kamonyi district, Southern province, household 3 is from Kayonza sector, Kayonza district, Eastern province, households 4, 5, and 6 are from Kiramurzi sector, Gatsibo district, Eastern province, and households 7, 8, and 9 are from Karangazi sector, Nyagatare district, Eastern province (Fig. 1). Each household raises 1 to 8 dairy cattle and milks cows for personal consumption and sales. If they sold all the milk at time of the field survey, the author interviewed on the milk processing techniques that they had inherited when they were little. Households 1 and 6 also raise 5 goats and sheep. They only milk cows and they do not milk goats or sheep in Rwanda. Households 7, 8, and 9 evacuated to Uganda located north of Rwanda in order to escape the Civil War. They returned to Rwanda in 1995 when civil order was restored after the 1994 Rwandan genocide. Households 1 and 2 are native-born and never evacuated the country.

3. Livestock and milking method

The livestock raised in Rwanda are cattle, goats, sheep, and chickens. They raise cattle for 1) milk production, 2) meat production through slaughter for ceremonial functions, 3) bridewealth, 4) cash income from the sale of milk or animal, and 5) compost production for use in crop fields. The cattle are respected and treated well in Rwanda, so



Fig. 2 Milking of local cow in Rwanda

they are not used for labors, such as plowing the crop fields or transporting goods. The goats are raised for 1) meat production through slaughter for ceremonial functions, special events or visits from good friends, 2) cash income from the sale of animal, and 3) compost production for use in crop fields. Goats and sheep are not milked or used for bridewealth in Rwanda.

The domestic cattle in Rwanda are Bashi, Watsui, Inyambo, and several other breeds belonging to the Ankole group¹⁸⁾. These cows only produce about 1 to 5 L of milk per day^{18,19)}. The Holstein breed was introduced recently to improve the domestic cattle. When the domestic cattle are bred with the Holstein cows, the improved breed can produce from about 5 to 10 L of milk per day. The cows are milked twice a day from 5 to 7 am in the morning and 4 to 6 pm in the evening. First, a calf suckles from the mother's udder for about one minute before it is separated and released near its mother (Fig. 2). Then the mother cow's back leg is tied to a string to restrain her while she is milked. It is the men's job to milk the cows. A man milks the cow from the left side. He squats, holding a container between his knees, and uses both hands to milk the cow. He will sometimes hold the container in one hand while he milks with the other hand. Children and young men stand on the other side while the cow is being milked. They tap and stroke the mother cow with a tree branch with leaves. This keeps the calf from attempting to suckle and keeps the flies off the mother cow. The man milks the cow for about three minutes and

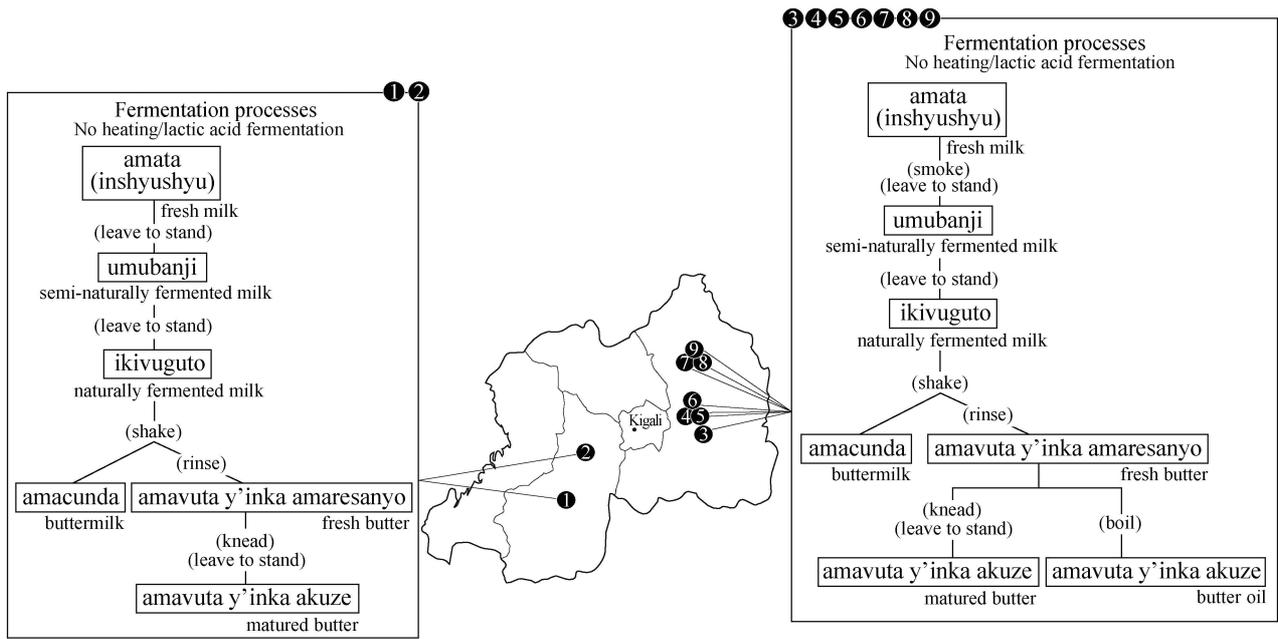


Fig. 3 Milk processing system in the highlands of Rwanda
 □ Product () Processing [] Additive

when he has finished, the calf is allowed to feed on the residual milk.

Milk collection centers have started to appear in villages in Rwanda since around 2012. With the establishment of milk collection centers, the agro-pastoralists started selling most of their milk for cash, reducing the amount of milk for personal consumption and at the same time, started processing milk less frequently.

Results

Raw milk is called amata in Kinyarwanda (Fig. 3) and freshly obtained milk is called *inshyushyu*. The freshly obtained milk is pasteurized and consumed or taken with tea. Raw milk is not pasteurized when it is used for processing.

1. Milk processing system in southwestern Rwanda

The author studied households 1 and 2 in southwestern Rwanda. The unpasteurized raw milk is poured into a small wooden container called *inkongoro*. *Inkongoro* is a cylindrical container carved out of a single piece of wood and is about 30 cm tall and has a diameter of about 10 cm. It is covered with *umutemeri*, a cover made out of



Fig. 4 Milk container called *icyansi* (right) and smoking pottery called *igicunga* (left)

woven Poaceae plants, to keep out flies, dirt, etc. The raw milk is transferred into a large wooden container called *icyansi* after it has cooled inside *inkongoro*. *Icyansi* is a cylindrical container of about 18 cm in diameter and about 40 cm in height (Fig. 4). The raw milk gradually undergoes natural fermentation, mainly from the lactic acid bacteria naturally contaminated inside *icyansi*^{20~22}). The raw milk which is milked in the morning changes to a semi-fermented milk in the evening. This semi-fermented milk now has a different consistency from the fresh raw milk, and is called *umubanji*. People do not drink *umubanji* in Rwanda.



Fig. 5 Churning of naturally fermented milk by the Gourd-made churn called *igisabo*

The raw milk is left inside *icyansi* for about two days and it turns into naturally fermented milk, *ikivuguto* when it has sufficiently fermented. *Umubanji* is liquid, but *ikivuguto* is thick gel. *Ikivuguto* happens often to separate into curd and whey inside *icyansi*. If it is to be consumed as a drink, *ikivuguto* is stirred with a wooden stick called *umutozo*, which is about 40 cm long and about 1.5 cm in diameter. When *ikivuguto* is available, it is almost always drunk with meals, and appears frequently in Rwandan diet. It is consumed by men and women, children and adults¹⁴⁾. It is also used to make butter. *Ikivuguto* is poured into a container called *igisabo* whose spout is sealed with a plug called *inzindaro* made of banana leaves. It is rocked on the ground to churn for about two hours (Fig. 5). The agro-pastoralists sometimes only take curd out of *icyansi* to churn inside *igisabo*. This churning *igisabo* is made out of a round gourd of about 45 cm tall and about 40 cm in diameter. It is rocked back and forth to churn, utilizing the round shape of the gourd.

After churning is completed, *igisabo* is tipped to pour out buttermilk called *amacunda*, leaving butter inside the container. Cold water is poured into *igisabo* to extract butter, which is transferred into a separate container along with the water. The butter is washed with fresh cold water to exclude the buttermilk. It is sometimes soaked in cold water for a day. Butter is called *amavuta y'inika*^{a)} and fresh butter is specifically called *amavuta y'inika amaresanyo*^{b)}. Karenzi¹³⁾ reported that the term of butter is called *kimuri*. The fresh butter is yel-



Fig. 6 Gourd-made butter container called *intsimbo*

lowish-white and only slightly flavor of butter. People do not eat *amavuta y'inika amaresanyo*, but apply it to hair and skin as cosmetics. It could also be used medicinally when applied to bruises and used for massages to mitigate pain. *Amavuta y'inika amaresanyo*, produced from single churning, is formed into a ball and stored in *intsimbo*, a storage container made of gourd (Fig. 6). This single *amavuta y'inika amaresanyo* ball is called *isoro*^{c)}. *Intsimbo* is about 25 cm tall and about 25 cm in diameter. They have also used unglazed pots called *urwabya* for storage in the past. The storage container is filled completely with *amavuta y'inika amaresanyo*.

Amavuta y'inika amaresanyo is taken out of the storage container every week to be pressed or hit with both hands to remove moisture^{d)}. The moisture removed from this process is called *amajagano*. *Amavuta y'inika amaresanyo* is formed back into a ball of *isoro* after moisture is removed by pressing and hitting it with both hands, and put back into the storage container. This process is repeated for two to five weeks. Then, it is left inside the storage container for about two months to ferment. The matured butter formed from this process is called *amavuta y'inika akuze*^{e)}. The *amavuta y'inika akuze* is dark yellow and has an intense smell. Its smell permeates the entire house when it is taken out of the storage container after being stored for two months. *Amavuta y'inika akuze* is used for cooking. It is mixed with and used to season boiled cassavas and beans. The food cooked with *amavuta y'inika akuze* is called *iburunge*. The agri-pastoralists in Rwanda believe that using fresh

butter, *amavuta y'inika amaresanyo* to matured *amavuta y'inika akuze* improves the flavor and taste of the butter.

The matured butter, *amavuta y'inika akuze*, is never heated to make butter oil in southwestern Rwanda. The butter can be stored as matured butter for about one year, if stored in a cool place of house in a storage container like *intsimbo* or *urwabya*. They said that in the past, the houses in Rwanda were well-ventilated and cool, because it was made of grass. The storage containers, such as *intsimbo* and *urwabya*, filled with matured butter, are placed inside a basket called *igiseke* made out of woven banana leaves to protect against mice and/or pest damage.

Buttermilk called *amacunda*, which is left after butter is removed, is never processed into the preservable form of cheese through further coagulating by heating, and draining. Children and women drink *amacunda*. If *amacunda* is available, it is always drunk with meals, but they say that men are not allowed to drink *amacunda*.

The characteristics of the milk processing system in southwestern Rwanda can be summarized as follows: 1) raw milk is used without pasteurizing by heating, 2) raw milk is naturally fermented by the naturally mixing microbial flora, 3) butter is made by churning naturally fermented milk for about two hours, 4) fresh butter is not used as food, 5) butter is matured for about two months before it is used as food, 6) butter is not heated to make butter oil, and 7) cheese is not made from raw milk, naturally fermented milk, or buttermilk. In summary, the milk processing system in southern Rwanda includes the use of no heating/lactic acid fermentation from the fermentation processes, in which the lactic acid bacteria are mainly used to naturally ferment the unpasteurized raw milk. They use the milk fat separation and preservation techniques to make butter from raw milk. However, the milk protein separation and preservation techniques for cheesemaking are absent from their milk processing system.

2. Milk processing system in northeastern Rwanda

The author studied households 3, 4, 5, 6, 7, 8, and 9 in northeastern Rwanda. Their milk process-

ing system also utilizes the no-heating/lactic acid fermentation process, which is similar to the one used in southwestern Rwanda.

The first difference between the milk processing techniques in northeastern Rwanda and southwestern Rwanda is that in northeastern Rwanda, the agro-pastoralists treat the inside of the milk containers, *inkongoro*, *icyansi*, and the churning container, *igisabo* with smoke¹³). A ceramic tool called *igicunga* and Poaceae plant are used to smoke the containers. *Igicunga* is about 15 cm long and 10 cm in diameter (Fig. 4). Poaceae plant is placed inside *igicunga*, and a window of about 3.5 cm diameter is opened for ventilation. There is a column of about 3 cm diameter projecting from *igicunga* to help with the smoking. Because the containers are treated with smoke, raw milk and naturally fermented milk smell of smoke.

The second difference is the length of time of churning. Households 3, 4, 5, 6, 7, 8, and 9 all completed churning naturally fermented milk, *ikivuguto* in *igisabo* in thirty minutes to an hour. The fresh butter, *amavuta y'inika amaresanyo*, has not been churned enough, so its consistency is like a mixture of butter and whipped cream. It is white and only slightly flavor of butter. *Amavuta y'inika amaresanyo* is not eaten, and if used, it is used as cosmetics.

The third difference is that the butter is heated to make butter oil in northeastern Rwanda. The fresh butter, *amavuta y'inika amaresanyo* is heated for several minutes to drain milk protein and moisture, and then made into butter oil. Butter oil is called *amavuta y'inika akuze*. Butter oil and matured butter has the same name. *Amavuta y'inika akuze* is a brown liquid when heated, but it solidifies when left at room temperature. They say that it can keep for a long time even at room temperature if stored inside in the shade. *Amavuta y'inika akuze* is used to flavor food that has only been boiled, added to meals as seasoning based on individual preferences, or used as medicine when applied to wounds.

Raw milk, naturally fermented milk, and buttermilk are also never processed into cheese in northeastern Rwanda. The characteristics of the milk processing system in northeastern Rwanda can be summarized as follows: It uses the no heating/

lactic acid fermentation from the fermentation processes to naturally ferment unheated raw milk by letting it to stand, and then churn the naturally fermented milk into butter. At the same time, it uses the milk fat separation and preservation techniques by heating butter to make butter oil, but the milk protein separation and preservation techniques for cheesemaking are absent from their milk processing system.

Discussion

1. Absence of milk protein separation and preservation techniques

Southwestern Rwanda and northeastern Rwanda both utilized the milk processing technique of no heating/lactic acid fermentation from the fermentation processes. In both regions, people fermented unpasteurized raw milk naturally, churned naturally fermented milk into butter, and used gourds for churning butter. Furthermore, they both used milk fat separation and preservation techniques, but neither used milk protein separation and preservation techniques to make cheese.

This section will discuss the reasons why the milk protein separation and preservation techniques did not develop in Rwanda. In West Asia, buttermilk was coagulated by heating, and then drained and sun-dried to make long-lasting dry cheese^{23,24}. The need to make cheese in West Asia comes from the fact that they cannot obtain raw milk throughout the year. They preserve milk protein from raw milk or buttermilk in a form of cheese during the season when they can milk their livestock, and then consume the cheese during the non-milking season. In the dry regions, such as West Asia, the primary livestock raised are sheep and goats. The milking period is only from January to September, because the sheep and goats breed seasonally. The livestock's seasonal breeding and lack of milk supply throughout the year have become the driving force in their need to fractionate and preserve milk protein from raw milk and buttermilk to make cheese.

The cattle in Rwanda breed year-round. The livestock breeding is closely related to day length^{25,26}. The livestock breeding loses seasonality, because there is not much change in day length

in Rwanda where it is near the equator. They can mate and reproduce throughout the year. Each household raises 1 to 6 cows, making it possible to milk any one cow at any season and obtain constant supply of raw milk throughout the year. When raw milk is always available, the agro-pastoralists can obtain protein from raw milk or buttermilk without having to make cheese. The year-round breeding and the constant supply of raw milk seem to be the reason why agro-pastoralists did not need to fractionate and preserve milk protein from raw milk and buttermilk, which is why their milk processing system did not lead to cheesemaking.

Cheesemaking is not practiced among the Rendille pastoralists²⁷ and Masai pastoralists⁸ from Kenya, located in the same equatorial region; Bodi pastoralists²⁸, Nuer pastoralists²⁹, and Narim pastoralists²⁸ from Sudan; Afar pastoralists and Tigray farmers from Ethiopia³⁰. The cows breed year-round and they can be milked throughout the year in these regions as well. They say that they may not milk the cows during the dry season, but most of the season, raw milk can be utilized even if low in quantity. However, the buttermilk is coagulated by heating to make fresh cheese in some regions of Ethiopia. The fresh cheese is processed, but it is not sun-dried to make it long-term storage. Cheesemaking in Ethiopia seems to have come from the 180 days of fasting when people do not consume animal products, such as milk and meat. It is thought that the processing of fresh cheese in Ethiopia is developed as a copying technique to the raw milk obtained on the fast days.

Since they do not make cheeses in Rwanda, the diet system in which they take naturally fermented milk and buttermilk developed inevitably. Boiling is the typical cooking method in Rwanda. Ingredients like cassavas, pumpkins, sweet potatoes, beans, and plantains are usually boiled. Meals are mainly made up of such starches with high carbohydrate content (Fig. 7). Potatoes and sweet potatoes are sometimes fried in oil, but others are boiled and seasoned with salt. Frying food and cooking pasta are relatively new culinary cultures introduced to Rwandan cooking. These meals are almost always accompanied by naturally fermented milk, *ikivuguto*. This fresh and creamy tasting



Fig. 7 Carbohydrates rich dish with naturally fermented milk called *ikivuguto*

ikivuguto fits very well with meals high in carbohydrates, and also adds nutritional, high quality protein and minerals. They said that they often ate a meal of only *ikivuguto* and sweet potato or *ikivuguto* with cassava and kidney beans when food was scarce in the past. They said they also ate *ikivuguto* with *mutshima*, an ugali made with sorghum powder and hot water. By combining naturally fermented milk with high carbohydrate meals, it seems to provide them with a balanced nutrition, which supported their dietary life^d). On one hand, the food culture of drinking naturally fermented milk and buttermilk seems to have developed in Rwanda, because they did not make cheese. On the other hand, butter making technology has developed in Rwanda, because butter was needed to season and flavor boiled foods. It is thought that the technique of fractionating and preserving milk fat from raw milk developed, precisely because it was necessary to their food culture.

2. Use of matured butter

In southwestern Rwanda, the agro-pastoralists churn naturally fermented milk into butter, but they do not heat butter to make butter oil. Why did their milk processing end with butter? Butter oil has more than 99% fat content and has a superior shelf life than butter, which has about 20% water content³¹). In hot climate regions, such as West Asia and South Asia, the final form of milk fat is always butter oil^{23,24,32}). It is possible that they chose to stop processing and preserve milk fat in a form of butter, because Rwanda is located in the

highlands where it is relatively cold condition throughout the year. At about 1,500 m above sea level, the average temperature is about 22°C throughout the year. It is also cool inside the well-ventilated houses. The temperature is even lower if the altitude is higher. The author have confirmed in cold climates of Tibet and Central Asia that butter indeed is the final form of milk fat fractionation and preservation in cold regions^{33,34}). It is believed that the milk fat fractionation ended with butter and there was no need to process it into butter oil, because Rwanda is located in the highlands.

In northeastern Rwanda, the agro-pastoralists processed butter into butter oil. Households 7, 8, and 9 escaped the Rwandan Civil War from the 1980's to the 1990's and temporarily sought refuge in Uganda. They returned to Karangazi, northeastern Rwanda in 1994 and currently make their living there as agri-pastoralists. The agro-pastoralists in Ethiopia³⁰), Kenya⁸), Sudan²⁸), and Uganda¹¹) heat butter to make butter oil to preserve milk fat with a long shelf life. Therefore, the butter oil processing used in northeastern Rwanda most likely started with the influence from Uganda. Household 9 said that the milk processing technique of heating butter to make butter oil was influenced by Uganda. They treat milk processing equipment with smoke in northeastern Rwanda. This smoking technique is also observed in Uganda, as well as Kenya, Ethiopia, etc.^{8,20,30,35}) The final form of milk fat separation and preservation used to be butter, but it can be speculated that the agro-pastoralists started heating butter to fractionate and preserve butter oil in northeastern Rwanda with the influence of Uganda.

The characteristic of milk fat usage in Rwanda is that they eat matured butter, but they do not consume fresh butter. They differentiated between fresh butter called *amavuta y'inika* and butter that had been matured inside a storage container for about two months called *amavuta y'inika akuze*. As explained before, *amavuta y'inika akuze* has a very intense smell, which spreads throughout the house when it is taken out of the storage container. The people of Rwanda utilize this smell to flavor boiled cassavas and beans by mixing it into the dish. Fresh butter is not used in this manner, because it does not have such a strong flavor. In other words,

the people of Rwanda regard butter on the basis of its strength of flavor and how much it can improve the taste when added to dishes rather than its shelf life. The fresh butter, *amavuta y'inika* and matured butter, *amavuta y'inika akuze* are distinguished based on whether or not it had a strong flavor. Butter oil processing spread in northeastern Rwanda with Uganda's influence, but it is believed that butter oil and matured butter are both called *amavuta y'inika akuze*, because they both add great flavors when mixed with other foods. From this case study on butter oil, it is understood that the value of butter lies in its flavor for the people of Rwanda. Such case study in which people distinguished forms of butter based on the strength of flavor, has not been confirmed outside of Rwanda and Uganda^{6,35}). It can be said that the African inland regions in the highlands near the equator, including Rwanda, have developed a very unique milk culture.

Acknowledgements

This study was partly supported by the 2017 fiscal year's KAKENHI Grant from the Japan Society for the Promotion of Science (JSPS), Japan (Grant Number No.26257014). The authors owe a great deal of thanks to the local agropastoralists in Rwanda for offering their hospitality and kindness. We also thank Miss NAGAI M. and Mr. HISHIDA O. of JICA (Japan International Cooperation Agency) RWANDA OFFIC, Mr. FUJIHASHI M. of JOCV (Japan Overseas Cooperation Volunteers), Mr. KINOSHITA K. of RWA MITTV LTD, and Mr. KATO Y. of Obihiro University of Agriculture and Veterinary Medicine for supporting the field survey.

Notes

- a) *Amavuta y'inika* in Kinyarwanda means "oil of cow".
- b) *Amavuta y'inika amaresanyo* in Kinyarwanda means "still fresh oil of cow".
- c) The plural of *isoro* is called *amasoro*.
- d) The action of hitting with both hands is called *kuyakubura*, and the action of pressing down with both hands is called *kuyakumura*.

- e) *Amavuta y'inika akuze* in Kinyarwanda means "aged oil of cow".

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ルワンダの乳加工体系

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ルワンダは、西アジアから続く乳文化圏の南端にあり、乳文化のアフリカ大陸における伝播・変遷を検討するにおいて極めて重要な位置にある。そこで本稿は、ルワンダの乳加工体系を現地調査により把握し、ルワンダの乳加工技術の特徴を明らかにすることを目的とした。2018年3月に農牧複合民9世帯を対象にルワンダで広域調査をおこなった。ルワンダの乳加工体系は、生乳を加熱殺菌することなく、自然に混入してくる微生物叢を利用して生乳を自然発酵させる発酵乳系列群・非加熱乳酸発酵亜系列の乳加工技術を採用していた。ルワンダの乳加工体系の特徴は、生乳からバターとして乳脂肪を分離・保存する技術を採用するが、チーズとして乳タンパク質を分離・保存する技術は欠落しているところにある。ルワンダで乳タンパク質の分画・保存技術が発達しなかった理由は、家畜の周年繁殖性および生乳の周年供給性によっていると考えられた。チーズを加工・利用しないため、ルワンダの食文化は、自然発酵乳とバターミルクが炭水化物含量の多い食事と一緒に摂取される食事体系となっている。ルワンダの乳脂肪の分画・保存技術での特徴は、バターが最終形態となっていることである。ルワンダが高原に位置し、一年を通じて比較的冷涼な生態環境にあることから、バターが乳脂肪の分画・保存の最終形態となったものと考えられた。ルワンダの人のバターの認識は、長期保存が可能かどうかというより、料理に添加した際に香りが良くなり、味覚が向上するかどうかという香りの強弱を基準にしており、ルワンダを含むアフリカ大陸内陸部赤道付近高原地域は極めて特異的な乳文化を発達させてきたと言える。

キーワード：ルワンダ，乳加工技術，冷涼，高原，食文化