Sveriges lantbruksuniversitet
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# AARUUL – A MONGOLIAN DRIED CURDLED MILK

## – Evaluation of the consumer acceptance and the health aspect

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# Aaruul – A Mongolian dried curdled milk
# - Evaluation of the consumer acceptance and the health aspect

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## Abstract

This study is part of a project that aims to investigate the possibility to develop food products that can offer quality and distinctive Mongolian advantage internationally. Different types of aaruul, a Mongolian traditional dried curdled milk, was investigated for its health aspects and acceptability among the international community in Ulaanbaatar. Various Mongolian dairy sources (milk from cow, yak, horse, goat and camel) were used to produce the aaruul and the possibility to develop aaruul from the different types of milk sources was assessed. 76 potential consumers evaluated the overall acceptance of six samples of aaruul (based on cow milk, yak milk, goat milk, camel milk, cow milk with the addition of dried sea buckthorn and cow milk with the addition of dried gojiberries). No aaruul based on horse milk were included in the acceptance test, due to the demonstrated inability of horse milk to form a curd when fermented.

The results from this study indicate that aaruul does not extensively appeal to non-Mongolians. Aaruul based on cow milk with the addition of gojiberries had the highest acceptance of the six samples, but still it only reached to between "*neither like or dislike*" to "*like it slightly*" on the hedonic scale. A literature review showed that aaruul possess many health beneficial properties, such as being a good source of vitamins, minerals, healthy fatty acids and proteins.

Mongolian aaruul is a food product that can offer quality and distinctive Mongolian advantage to the world. Mongolian aaruul does not only have health as an added value, but it also has a cultural aspect added to its features. In order to make aaruul more healthy and palatable a review of the process, further studies and sensory evaluations are recommended.

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***Key words:*** *Aaruul; Dried curdled milk; Yak milk; Horse milk; Goat milk; Cow milk; Camel milk; Mongolia; Sea buckthorn, Gojiberries; Nutrition; Acceptance test*

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# 1. Introduction

Mongolia, landlocked between Russia and Asia, is a land of nomads. The country is one of the world's fastest growing economies, due to its huge quantities of mineral wealth. To the outside world, Mongolia is probably most known for its vast steppes and their father of the nation and famous conqueror Chinggis Khaan. The country is less recognized internationally for its cuisine. However, the food from Mongolia exhibits unique characteristics and the traditional food reflects the nomads' life on the move in harsh weather conditions.

## 1.1 Background

Traditional Mongolian food is predominantly based on meat and dairy products. This is food that the nomads produce from their domesticated animals, such as cattle, sheep, goats, horses, camels and yaks. Those simple based materials are produced using a variety of methods into different products, such as airag (fermented horse milk), khorkog (mutton cooked with hot stones) and urum (clotted cream). Aaruul is another popular food that is based on milk. This product is made of curdled milk that has been dried in the sun and air. It is primarily consumed as a snack, sometimes flavoured with sugar and berries, and its long shelf life fits perfectly in the nomadic lifestyle. It is commonly believed that aaruul is the factor behind the Mongolians strong and healthy teeth.

Mongolians also have a vast tradition of wild fruit utilization. Sea buckthorn and Goji berries are two of the wild fruits that can flourish in the extreme weather conditions on the mountains and in the dry sandy Mongolian soils. They have been used as both medicinal and food plants and the berries are noted for their high levels of nutritional important components (Kumar *et al.*, 2011, Potterat, 2010) and they are a good source of local available supply of vitamins and other beneficial substances.

In the 1990s there was a rapid transition from state-run to market-run economy in Mongolia. After the transition to market-run economy, the dairy industry collapsed and a large part of the dairy products were imported. Dairying provides much-needed nutrition, regular incomes and jobs in the rapidly urbanizing country. The huge wealth of traditional milk products will continue to play a central role in Mongolian culture and the livelihoods of nomadic herders (Dugdill, 2007).

## 1.2 Project background and aim

Mongolian companies in general compete on price rather than quality or a unique advantage. A flood of cheap, good-quality imports into Mongolia will destroy many domestic businesses and agricultural producers. The Mongolian businesses will be unable to compete on price. In fact, low-cost competition from other countries has already damaged them. The inevitable rise in the Mongolian currency (tugrik) in the future will go further and it will destroy all industries competing on price alone (domestically or internationally). Mongolia could compete internationally by selling products with extra value that has been added in Mongolia. A unique value, which international consumers know about and appreciate, will bring profit and commercial power back to Mongolia. The solution for Mongolian companies is therefore to develop brands offering quality and distinctive Mongolian advantage to the world (MNMCO, 2012).

This study is part of a project that aims to investigate the possibility to develop food products that can offer quality and distinctive Mongolian advantage internationally. The study will focus on the traditional Mongolian product aaruul. Various Mongolian dairy sources (milk from cow, yak, horse, goat and camel) will be used to produce aaruul and the possibility to develop aaruul from the different types of milk sources will be evaluated. An acceptance assessment will be performed to find out the potential consumer's appeal of the different types of aaruul. The potential consumer is in this study broadly specified as non-Mongolians. The addition of the native Mongolian berries of sea buckthorn and goji will be investigated in order to possibly make the product more palatable and increase the nutritional value. The study will also evaluate the health and cultural aspects that possibly will make the product unique on the market.

The main outcome of the project will be a report discussing and concluding if aaruul could be a potential Mongolian product for export. The feasibility to make aaruul out of the different types of milk sources and an acceptance test to find out how potential customers perceive the products will be performed and further discussed. The gain from adding sea buckthorn or goji to the products will also be investigated. The study will define the potential health benefits the product will offer the consumer and what possible advantages it may have internationally. All activities will be focusing on basic research, development of prototypes and consumer tests.

This project is performed in collaboration with the Chamber of Commerce in Mongolia. Trials to produce the product will be performed, but only in small scale. No specific food industry is involved in this project. Assessments with product packaging, shelf life of the product or financial aspects will not be included in this project. This is a pilot study and the market for aaruul is therefore not yet specified.

# 2. Materials and methods

## 2.1 Materials

Fresh whole milk from goat, yak, horse, camel and cow was obtained from private herds in Mongolia. The berries were obtained from the local market.

A local dairy in Ulaanbaatar supplied the starter culture for the aaruul. The culture was a freeze-dried Thermophilic yoghurt culture of the brand CHR HANSEN. The culture is a mixture of *Streptococcus thermophilus* and *Lactobacillus delbrueckii* and it is known to produce yoghurt with very consistent body, moderate flavour and low post-acidification.

## 2.2 Method

### 2.2.1 Literature review

A review of the literature was performed to find information regarding the health aspects of the raw materials in aaruul. The review also assessed the feasibility to make the aaruul out of the different types of milk and the theoretical aspects of the final product's potential health benefits.

### 2.2.2 Preparation of aaruul

All trials and production of aaruul were performed in a domestic kitchen. The aaruul was prepared according to the traditional process for making aaruul, with the exception of drying the product on the roof of a yurt in the sun. The whole milk was pasteurized before incubated with the starter culture. The milk was heated up in a water bath at 85°C for 30 minutes and cooled to 42°C. The pasteurized milk was inoculated with starter culture and the mixture was stirred (сүүгээ самрах) for 5 to 10 minutes and then incubated at 43°C for 4 hours. The curdled milk was placed in a cheesecloth (маарал) and the whey was drained off. The curd was cut into smaller pieces and dried completely in the sun (see picture Appendix A). The aaruul were stored at 3°C.

For the flavoured samples; the dried berries were added to the curd before cutting and drying the aaruul.

### 2.2.3 Consumer acceptance test

An acceptance test was carried out using a nine point hedonic scale. Samples of aaruul were made of milk from yak, goat, cow, camel, cow with addition of dried sea buckthorn berries and cow with addition of dried gojiberries. Six different samples of aaruul were prepared in total and they were presented in white plastic cups. All samples were marked with a three-digit code and the order of presentation of samples was randomized for each participant. The recruitment of consumers was performed accordingly to ensure that only non-Mongolians were part of the test. The participants were given a questionnaire (see Appendix B). They were instructed on how to evaluate the samples and asked to rinse their palates with water before each sample.

A sample size of minimum 75 persons was used in order to cover for most tolerable levels of risk (Lawless & Heymann, 2010).

### 2.2.4 Statistical analysis

In order to present the data in a visual manner, the data were presented and analysed using simple graphs (Microsoft Excel 2008 for Mac). The acceptance responses of the six samples were also analyzed by analysis of variance (ANOVA - Tukey's test) to determine if statistical difference existed at p <0,0001 and the significance difference at 10% and 5% was used for means comparison (FIZZ Software, Version 2.47, Biosystèmes, Courternon, France).

# 3. Theory background

A literature review with information about aaruul and its raw materials are summarized below.

## 3.1 Milk and nutrition

Milk is a complex mix of fat, protein, carbohydrates, minerals and vitamins (Andersen, 1993). Milk is associated with health benefits, due to the high nutritious content. It contains bioactive peptides, probioticbacteria, antioxidants, vitamins, specific proteins, oligosaccharides, organic acids, highly absorbable calcium, conjugated linoleic acid and other biologically active components (Bhat & Bhat, 2011). Milk and dairy foods contribute with essential nutrients to the diet, such as calcium, phosphorus, magnesium, zinc, potassium, vitamin A, vitamin B12, riboflavin and others (Ebringer *et al.*, 2008). Milk is a very variable biological fluid. Fluid milk composition and flavour variation are attributed to types of feed, health, seasonal variation, breed, milk handling, storage conditions, processing and packaging etc. (Alvarez, 2009, Fox & McSweeney, 1998). Therefore the sensory characteristics of any dairy product are most dependent on the quality attributes on the milk as an ingredient (Alvarez, 2009).

### 3.1.1 Milk fat

Milk fat is a mixture of different fatty-acid esters called triglycerides, which are composed of glycerol and various fatty acids. Milk fat is also composed of di- and monoglycerides, sterols, carotenoids, vitamins (A, D, E and K) and minor trace elements (Bylund, 1995). In contrast to most dietary guidelines, recommending the consumption of fat reduced milk and milk products, Kratz *et al*., (2013) suggest that high fat dairy consumption is inversely associated with obesity risk. They also stressed that the fatty acid profile of milk is affected by the animal's diet. Devle *et al*., 2012 showed that animals on summer pasture increase their C18:1 (oleic acid) content in milk, which is considered to be a favourable fatty acid for human health (Haug *et al*., 2007) and decreases the C16:0 (palmitic acid) fatty acid, which is a known contributing factor for increased risk of cardiovascular disease (WHO/FAO, 2003). Milk contains trans fatty acids, which also are a known contributing factor to cardiovascular disease. It is therefore recommended to consume food that provides a very low intake of trans fatty acids (less than 1% of daily energy intake) (WHO/FAO, 2003). The assumed health negative trans fatty acids were analyzed to be highest in ruminant milk (0.7–1.0%), but milk from these species contained also the highest amount of the health beneficial CLA (0.4–0.7%) (Devle *et al*., 2012). ALA (α-linolenic acid –18:3 n-3) and LA (linoleic acid – 18:2 n-6) are essential fatty acids for humans and both are found in relatively small amounts milk (Devle *et al*., 2012). They are required for normal physiological functions linked to membrane integrity and regulatory cell signals. It is important that these two fatty acids are in balance in order to decrease the risk of coronary heart disease (Wijendran & Hayes, 2004). WHO/FAO, (2003) suggest the recommended optimal balance between intake of n-6 polyunsaturated fatty acids and n-3 polyunsaturated fatty acids to be 5-8% and 1-2% of daily energy intake, respectively.

##### *3.1.1.1 Conjugated Linoleic Acid*

Conjugated Linoleic Acid (CLA) is a group of naturally occurring 18-carbon fatty acids, which are in various amounts found in milk and other products mostly of ruminant origin. Milk fat contains trace amounts of many CLA isomers, but *cis*-9, *trans*-11 CLA is the main isomer in milk fat, representing about 75-90% of the total CLA. The presence of CLA in dairy products is related to the rumen fermentation of dietary polyunsaturated fatty acids and ruminant derived foods are the major dietary source of CLA in human diets. The animal's diet is the most significant factor that affects the CLA content of milk fat. The consumption of lush pasture and/or feed that provide seed oils that are high in linoleic acid may enhance the CLA concentration in milk fat. Some CLA isomers have shown to offer health benefits and disease prevention. (Bauman *et al*., 2011). There are many exciting evidence on the beneficial health effects of CLA, such as being inhibiting proliferation of human malignant melanoma, colorectal, breast and lung cancer cell lines (Parodi, 1997). Larsson *et al*., (2005) examined the associations of long-term high-fat dairy food consumption and CLA intake and the incidence of colorectal cancer. Their results suggest that high intake of high-fat dairy foods and CLA may reduce the risk of colorectal cancer. CLA has also been demonstrated to decrease body fat mass in overweighed humans and may help maintain initial reductions in body fat mass and weight in the long term (Gaullier *et al*., 2005). Another interesting health benefit of CLA is it's anti inflammatory mechanisms and the fatty acids has shown to enhance immune functions, while inhibiting adverse inflammatory reactions (Bassaganya-Riera *et al*., 2002). However, the functional food role of CLA in health maintenance and the prevention of chronic diseases in humans remain to be clearly established (Bauman *et al*., 2011).

### 3.1.2 Bioactive proteins and peptides

Cow's colostrum and milk have proven a valuable natural source of biologically active components, beyond their well-known nutritional attributes. Milk proteins are a good source of amino acids and nutrients, which actively can regulate and promote human health. The bioactive components have been demonstrated both *in vitro* and *in vivo*. The individual protein fractions; immunoglobulins, lactoferrin, lactoperoxidase system, α-lactalbumin and β-lactoglobulin have shown to possess valuable bioactive properties. These components are found in abundance in cheese whey. Major bioactive whey proteins include β-Lactoglobulin, α-Lactalbumin, Immunoglobulins (IgG, IgM, IgA), Glycomacropeptide, Lactoferrin, Lactoperoxidase, Lysozyme and Growth factors (Korhonen, 2011). Whey proteins deliver health benefits such as improved muscle mass and function (Crittenden *et al*., 2009), improved outcome of weight loss (Pilvi *et al*., 2009), prevention and/or treatment of hypertension (high blood pressure) (Lopéz-Fandino *et al*., 2006), stimulates insulin release and reduces postprandial blood glucose excursion (Frid *et al*., 2005), preventing enteric microbial infections (Ochoa & Cleary, 2009), protection of the stomach mucosa from ulcerative lesions (Mezzaroba *et al*., 2006) and anti-cancer effects (Bounous, 2000).

Casein is the major protein in milk and it is known to have a good nutritious value, due to its amino acid composition and calcium, phosphate and other trace elements linked to the casein molecule (Korhonen, 2011). Caseins are also a good source of bioactive peptides, which are released in the stomach during casein digestion (Chabance *et al*., 1998, Silva & Macata, 2005) or during food processing via specific enzyme proteolysis. Similar as the whey proteins, also the casein proteins deliver health benefits by possessing antithrombotic, antihypertensive, opioid, immunomodulatory and antimicrobial activities (Silva & Macata, 2005).

### 3.1.3 Minerals and vitamins

Milk contains a number of minerals and they occur in solution in milk serum or in casein compounds. The most important minerals are calcium, sodium, potassium and magnesium and the amount vary during the lactation period (Bylund, 1995). Calcium is an important mineral in the body, due to its involvement in the formation of bones. Calcium also regulates many metabolic and physiological functions, the release and activation of enzymes and the mineral participates in the blood clotting process. Calcium deficiency results in a decrease in the bone mass and the risk of fractures increases. Osteoporosis is partly caused by a deficiency in calcium. Sodium is an essential mineral for the human body. The mineral is important for the regulation of the acid-base balance in the body. It also plays an important roll for the osmotic pressure of the extracellular fluid and blood volume. Sodium deficiency may lead to muscle cramps, lost of appetite and circulation disorder. Similar as sodium, potassium also takes part in the acid-base balance in body. Potassium is important for the nerve and muscle function, kidney function and the blood pressure control in the body etc. Potassium deficiency may cause depression, muscle weakness, arrhythmia or even cardiac arrest. These symptoms are due to disturbed cell membrane functions. Magnesium is an important mineral for optimal growth and for many biochemical and physiological functions in the body. For example are the nerve and muscle cells dependent on magnesium in order to function. Magnesium deficiency is a relatively rare disorder, but it may lead to neuromuscular disorders, muscle weakness and cramps (Abrahamsson *et al.*, 2003).

Milk is a good source of vitamins and the best known are A, $B_1$, $B_2$ and D. Vitamin C is also a known vitamin in milk and this vitamin is sensitive to heat, especially in the presence of air and certain metals. The other vitamins suffer little of no harm from heat (Bylund, 1995). Vitamin C (ascorbic acid) has many important roles to play in the human body. For example the vitamin assists in the production of collagen, it is also an antioxidant and it enhances the iron absorption in the body (Abrahamsson *et al.*, 2003). Vitamin C deficiency cause for example fatigue, pyorrhoea and susceptibility to infection (scurvy) (Bylund, 1995). Vitamin A is a fat-soluble vitamin. The vitamin includes different substances with a so-called “vitamin A effect”. Vitamin A is important for good vision, reproduction and for the maintenance of the immune system etc. Vitamin A deficiency may lead to night blindness, cornification of skin and mucosa. In severe cases it may lead to an eye condition called xerophthalmia, where the eye’s mucous dries out and may cause blindness. Vitamin $B_1$ (thiamine) is important for the metabolic system in order to release energy from food. Thiamine is part of the coenzyme thiamine diphosphate (TDP). This enzyme has many important functions, such as producing ribose, which is part of both DNA and RNA. Symptoms of thiamine deficiency are for example loss of appetite, problems concentrating, tiredness, weight loss and constipation. Vitamin $B_2$ (riboflavin) is an important vitamin for normal growth. Riboflavin is part of two different coenzymes (FMN and FAD). The enzymes are required for important reactions in the body, such as the cellular respiration system. Symptoms of riboflavin deficiency include red coloured oral mucosas, cracked and red lips, inflamed eyes and nose etc. Vitamin D is a fat-soluble vitamin. Vitamin D is not only one vitamin, but a group of secosteroids with similar structures. The vitamin is involved in the control of the calcium and phosphate levels in the blood. Vitamin D deficiency may result in rickets or osteomalacia – softening of bones. Also cramps, due to low calcium levels, may be a symptom of vitamin D deficiency (Abrahamsson *et al.*, 2003).

#### 3.1.4 Dental caries

Dental caries are due to the breakdown of tooth enamel by acids, which are formed during the fermentation of sugars and starches by plaque bacteria. The demineralization of teeth also occurs directly when consuming acid food. Milk contains various components, such as calcium, phosphate, protein and lipids that have shown to protect against this demineralization process (Wells, 2001). Epidemiological studies confirm associations between milk/cheese intake and protection against caries (Johansson, 2002) and a study by Moynihan *et al*., (1999) suggest that cheese containing meals increase plaque calcium concentration and therefore protect against dental caries.

#### 3.1.5 Light activated flavour

Off-flavour development in milk and dairy products, is formed when the milk is exposed to light, either sunlight or fluorescent light. The flavours are a result from autoxidation catalyzed by the light. There are two different reactions causing the different off-flavours, one is caused by a lipid oxidation and the other one is caused by protein degradation. The vitamin riboflavin ($B_2$) is an essential factor in the light induced oxidation in milk (Walstra *et al*., 1999). Consequently light induced volatile compounds, such as pentanal, hexanal, heptanal and dimethyl disulfid in milk are influenced by the concentration of riboflavin and the fat content in the milk (Lee & Min, 2009). However, light exposure does not only affect the flavour in the milk, it is also an important factor deteriorating nutritional values of the milk, such as vitamin A (Whited *et al*., 2002). Saffert *et al*., (2006) showed in their study that retinol (vitamin A) and riboflavin (vitamin $B_2$) in milk were significantly reduced when exposed to fluorescent light. It has been demonstrated that the addition of ascorbic acid protects the photodegradation on riboflavin and furthermore the off-flavours in the milk (Jung *et al*., 1998, Lee *et al*., 1998). Similar results were obtained by van Aardt *et al*., (2005). They suggest that addition of low levels of antioxidants ($\alpha$-Tocopherol/Ascorbic Acid) to milk protects its flavour of ten hours of exposure to light.

Also cheese get affected by exposure to light, which causes formation of off flavours, colour changes, loss in nutritional value and formation of toxic products (e.g. cholesterol oxides) (Mortensen *et al*., 2004). Kim *et al*., (2003) investigated light-induced volatile compounds in goat cheese and found that cheese stored under light had more off-flavours than cheese stored in the dark. The trained sensory panellists described the sample that was stored under fluorescent light for two days as rotten, soapy, rancid and cheesy.

### 3.2 Yak milk

Yak (*Bos grunniens*) in Mongolia generally belongs to the type called ”plateau” or ”grassland” yak. The milk yield per yak is relatively low compared to modern dairy cattle standards, but it may reach up to 700 litres in a 6 months period following calving (Wiener, 2011). Yak milk is rich in protein, casein and fat if compared to cow's milk (Nikkhah, 2011). The yak milk protein and milk fat content have shown to increase with increasing altitude (Bin *et al*., 2010). Although the milk composition varies slightly among different yak breeds and different locations etc. the yak milk generally contains 16.9-17.7% solids (dry matter), 4.9-5.3% protein, 5.5-7.2% fat, 4.5-5.0% lactose and 0.9-0.9% minerals (Dong *et al*., 2007). Yak milk has a sweet fragrance and a golden rich colour. Since the milk has higher fat and protein content than cow milk, yak milk quality is often referred as "thick" or "rich" (Park, 2011).

### 3.2.1 Milk fat

The fatty acid composition of yak milk was investigated in a study by He *et al*., (2011) and the results showed that the unsaturated fatty acids in the milk accounted for 35.38% of total fatty acids. The unsaturated fatty acids were mainly monounsaturated fatty acids (31.48% of total fatty acids) and they were higher compared to the monounsaturated fatty acids in cow and goat milks. In a study by Or-Rashid *et al*., (2008), cheeses made from yak milk and dairy cow milk were compared in terms of fatty acids. The n-3 polyunsaturated fatty acids in the yak cheese was shown to be 3.2 times higher than in the dairy cow cheese and the ratio of n-3 polyunsaturated fatty acids and n-6 polyunsaturated fatty acids was closer to 1 in the yak cheese than in the dairy cow cheese (0.87 vs. 0.20). Also the amounts of *cis-9, trans*-11 CLA and *trans*- 11-C18:1 in yak cheese were 4.2 and 4.6 times higher, respectively, than those in dairy cow cheese. Based on their findings, the authors suggest that yak cheese could be classified as a healthy food in human diets.

### 3.2.2 Proteins

Proteins of yak milk mainly consist of the four individual caseins ($\alpha_{s1}$-casein, $\alpha_{s2}$-casein, $\beta$-casein and $\kappa$-casein) and the major whey proteins ($\alpha$-lactalbumin, $\beta$-lactoglobulin, serum albumin, lactoferrin and immunoglobulins) (Sheng *et al*., 2008). A study on Mongolian yaks performed by Ochirkhuyag *et al*., (1997) showed that caseins of yak are nearly identical with that of cow. The individual casein composition is 43.2% $\alpha_s$-casein, 35.4% $\beta$-casein and 16.4% $\kappa$-casein. The yak milk caseins have shown to possess an inhibitory activity of angiotensin-I-converting enzyme. These kind of inhibitors are important for the treatment of hypertension, which means yak milk caseins could be potentially commercial attractive as a 'health-enhancing ingredient' in the production of functional foods (Mao *et al*., 2007). In a study by Li *et al*., (2011b) a comparison of the immunogenicity of yak milk and cow milk was performed. The results in the study indicated that proteins in yak milk may be less allergenic than cow milk protein, but what caused this was not fully determined.

There is a lack of knowledge on the whey proteins of yak milk and little is known about their specific nutritional benefits (Li *et al*., 2010).

### 3.2.3 Minerals and vitamins

The concentrations of some minerals of yak milk are presented in table 1. Sun *et al*., (2012) reports differences in the composition of milk among farms and explains them by the different composition of the pasture grass and soil. Sheng *et al*., (2008) explains the variation in the mineral constituents of milk to be attributed to factors such as stage of lactation, season, nature of soil, breed, feeding programme and contamination.

Data for vitamins in yak milk were absent in the literature. This was also observed by Medhammar *et al*., (2012). However, due to the relatively high fat content in yak milk the concentration of fat-soluble vitamin can be expected to be high (Indra & Magash, 2002).

**Table 1.** The mean mineral composition of yak milk.

| Element (mg/kg) | Li *et al.*, 2011a |
|---|---|
| **Calcium (Ca)** | 1545 |
| **Potassium (K)** | 1372* |
| **Magnesium (Mg)** | 154 |
| **Sodium (Na)** | 341* |
| **Phosphorous (P)** | 922 |
| **Sulphur (S)** | 399* |
| **Zinc (Zn)** | 7.31 |
| **Iron (Fe)** | 0.57 |
| **Manganese (Mn)** | 0.06 |
| **Copper (Cu)** | 1.07 |

* data from Sun *et al.*, (2012)

## 3.3 Horse milk

The Mongol horse breed is a relatively small horse and it is traditionally used for riding, caring for livestock and hunting. The milk yield is approximately 150 litres (approximately 2.5 liters/day) per lactation period and the milk is commonly used to make airag (fermented horse milk) and dried milk products (Suttie, 2005). In a recent study by Minjigdorj *et al.*, (2012) the average daily daytime milk yield for Mongolian native breed mares was reported as 3975 ml. They also reported the milk composition as 11.0% total solids (dry matter), 2.0% fat, 6.6% lactose, 2.2% protein and 0.3% ash on average. Horse milk is low in fat compared to other mammals and it has also shown to be richer in lactose and lower in protein compared to the other types of milk for human consumption (Doreau & Martin-Rosset, 2011). Not much is documented about the flavour profile of horse milk, but in Sheng and Fang, (2009) the milk is described as less white and more translucent than cow milk. It has a sweet, but at the same time a somewhat harsh taste and an aromatic flavour.

### 3.3.1 Milk fat

Pikul & Wójtowski (2008) demonstrated in their study that there are significant differences in the contents of fat and cholesterol as well as in the composition of most fatty acids during the stage of the mare's lactation. Also dietary variations affected the composition of the milk. Saturated fatty acids made up approximately 45%, the monounsaturated fatty acids 32% and the polyunsaturated fatty acids 23% of total fatty acids in the milk of horses. Similar results were also obtained by Devle *et al.*, (2012), with the exception of a slightly higher concentration of saturated fatty acids (56.6%). Horse milk showed to contained only small quantities of the CLA acid (less than 0.1%) (Malacarne *et al.*, 2002, Pikul & Wójtowski 2008, Jahreis *et al.*, 1999). The most abundant fatty acid found in Mongolian horse milk was palmitic acid (16:0) and ALA (α-linoleic acid -18:3 n-3) and oleic acid (18:1) (Minjigdorj *et al.*, 2012).

### 3.3.2 Proteins

The whey protein fraction represents approximately 40%, which make the horse milk more similar to human milk than cow milk (Malacarne *et al.*, 2002). The whey protein fractions in Mongolian horse milk contained 37.1% α-lactalbumin, 29.6% β-lactoglobulin, 16.1% immunoglobulin, 8.1% lactoferrin and 4.7% lysozyme (Minjigdorj *et al.*, 2012). The milk contains more lysozyme and lactoferrin than cow milk and these two proteins are known for their antimicrobial activity (Doreau & Martin-Rosset, 2011). Horse milk has shown to have biophysical and biochemical characteristics to human milk. In a study by Businco *et al.*,

(2000) the allergenicity of horse milk in a population of selected children with severe IgE-mediated cow's milk allergy was investigated *in vitro* and *in vivo*. The result showed that the proteins in the horse milk do not react strongly with human IgE and this suggests that horse milk may be a suitable substitute for cow milk in cases of severe IgE-mediated cow milk allergy.

The casein fraction in horse milk represents about 40-60% (Doreau & Martin-Rosset, 2011). Horse milk casein is composed of nearly equal parts of $\alpha_s$-casein and β-casein (Malacarne *et al*., 2002). The $\alpha_s$-casein consists of mainly $\alpha_{s1}$-casein. κ-casein and γ-like casein has also been identified in horse milk (Egito *et al*., 2002).

### 3.3.3 Minerals and vitamins

Horse milk contains approximately 5 gram of minerals per kilogram of milk (Doreau & Martin-Rosset, 2011). The mineral content has been reported to be lower than that of milk from other farm animals (Csapó-Kiss *et al*., 1995). In Table 2 the concentration of some minerals in horse milk is presented.

The pattern of vitamins in horse milk is characterized by an overall high content of vitamin C, compared to many other dairy species (Doreau & Martin-Rosset, 2011). The vitamin C content presented by Csapó *et al*., (1995) are in line with Sheng and Fang, (2009) compiled list of vitamin C content in horse milk. An overview of the vitamin content of horse milk is shown in table 3.

**Table 2.** The mean concentrations of some minerals in horse milk.

| Element (mg/kg) | Csapó-Kiss *et al*., 1995 |
|---|---|
| **Calcium (Ca)** | 823 |
| **Potassium (K)** | 517 |
| **Magnesium (Mg)** | 66 |
| **Sodium (Na)** | 167 |
| **Phosphorous (P)** | 499 |
| **Sulphur (S)** | --- |
| **Zinc (Zn)** | 1.99 |
| **Iron (Fe)** | 1.21 |
| **Manganese (Mn)** | 0.054 |
| **Copper (Cu)** | 0.23 |

**Table 3.** The mean vitamin content of horse milk.

| Vitamin (mg/kg) | Csapó *et al.*, 1995 |
|---|---|
| **A** | 0.34 |
| **D** | 0.0032 |
| **E** | 1.128 |
| **K** | 0.029 |
| **C** | 17.2 |
| **Thiamine ($B_1$)** | 0.16* |
| **Riboflavin ($B_2$)** | $3.9x10^{-7}$* |
| **Niacin ($B_3$)** | 0.5* |
| **Pantothenic acid ($B_5$)** | 3.2* |
| **Vitamin $B_6$** | ---- |
| **Folic acid ($B_9$)** | ---- |
| **Biotin** | ---- |
| **Vitamin $B_{12}$** | ---- |

*Adapted from Pearson, (1947)

## 3.4 Goat milk

Goats have been kept in Mongolia since ancient times for its meat, milk, hide and fibre production. There are five core populations of the Mongolian native goat (Bayandelger, Ulgii Red, Zavkhan Buural, Sumber, and Dorgon), but there are also other goat breeds in Mongolia, such as Mongolian and Russian crossbreeds (Takahashi *et al*., 2008). A goat's milk yield varies widely depending on breed, diet, stage of lactation, season and litter size etc., but the average yield is approximately 2 litres per day (Amigo & Fontecha, 2011, Solaiman, 2010). Approximate composition of goat milk is 12.6-13.1% total solids (dry matter), 4.1-4.3% fat, 4.3-4.5% lactose, 3.4-3.7% protein and 0.82-0.87% ash on average (Kondyli *et al*., 2012). A study by Clark and Sherbon, (2000) confirmed that goat milk with high percent total solids, solids non-fat, fat and protein coagulated faster and formed a firmer curd than milk that had lower levels of milk components. This indicates the importance of the distribution of milk components when producing curd products.

Products made from goat milk are recognized by its unique flavour. The sensorial properties of goat milk products are characterized by a specific and typical "goat" flavour, which generally is undesirable for direct consumption of the milk. However, for cheese production the unique flavour could be an advantage (Skjevdal, 1979).

### 3.4.1 Milk fat

The lipids in the goat milk contain a high proportion of medium-chain fatty acids, i.e., caproic (C6:0), caprylic (C8:0) and capric (C10:0). These are partly responsible for the "goat" flavour in the milk (Silanikove *et al*., 2010). The average fat content of goat milk is 4.1-4.3%. Total average CLA content in goat milk is approximately 0.47%, which was shown to be mainly cis-9, trans-11. However, the CLA concentration varies depending on the feed and between individual animals etc. Saturated fatty acids made up approximately 57%, the monounsaturated fatty acids 22% and the polyunsaturated fatty acids 4% of total fatty acids in the milk (Tsiplakou *et al*., 2006). Goat milk has shown to have an advantageous effect on the metabolism of lipids (compared to cow milk). A study by Alférez *et al*., (2001) showed that the consumption of goat milk reduces the level of cholesterol. The consumption of goat milk increases the biliary secretion of cholesterol and causes a decrease in plasma cholesterol levels. Similar results were obtained in a study by Lopéz-Aliaga *et al*., (2005). This effect was partly explained by the higher levels of medium-chain triglycerides in the goat milk compared with cow milk. Medium-chain triglycerides are more rapidly metabolized to produce energy compared to long-chain triglycerides.

### 3.4.2 Carbohydrates

Carbohydrates in goat milk include lactose, oligosaccharides, glycopeptides, glycoproteins, and nucleotide sugars. Lactose is the major carbohydrate in goat milk, but oligosaccharides are also found in high amount and diversity in the milk, particularly when compared to ovine and bovine milk (Amigo & Fontecha, 2011). Oligosaccharides are recognized as one of the anti-inflammatory components of milk, due to its prebiotic properties and its capacity to act as receptors for microorganisms. The goat milk oligosaccharide's anti-inflammatory effects were demonstrated in a study by Daddaoua *et al*., (2006) in which rats with experimental colitis were treated with the oligosaccharides. The results showed a recovery for the rats treated with oligosaccharides and the authors suggest that goat milk oligosaccharides may be useful in the management of inflammatory bowl disease. Similar results were obtained in a study by Lara-Villoslada *et al*., (2006), which also showed that goat milk oligosaccharides reduce intestinal inflammation.

### 3.4.3 Proteins

The casein fraction of goat milk is approximately 83% of total proteins and the whey fraction approximately 17% (Ceballos *et al*., 2009). The main whey proteins of goat milk are β-lactoglobulin and α-lactalbumin. Goat milk is characterized by high β-lactoglobulin and low α-lactalbumin compared to bovine milk (Moatsou *et al*., 2005). The main casein protein is β-casein (Abd El-Salam & El-Shibiny, 2013). Park (1994) mentions in his article "hypoallergenic and therapeutic significance of goat milk", that there is evidence available suggesting that goat milk is a hypoallergenic alternative to cow milk in the human diet. The symptoms related to cow milk protein, such as digestive disorders, asthma and eczema are less characteristic for patients consuming goat milk. However there are limited data on the basic immunology and biological mechanisms to support the clinical observations, why goat milk can substitute for cow milk in allergic patients.

### 3.4.4 Minerals and vitamins

There is variability in the mineral and vitamin composition in goat milk depending on factors such as diet and lactation stage etc. Compared with cow milk, goat milk has an overall higher level of calcium, phosphorous, potassium and magnesium and a lower level of sodium (Amigo & Fontecha, 2011). The mineral composition of goat milk is shown in table 4.

Goats convert all carotene into vitamin A and therefore the milk has a higher content of vitamin A than cow milk. On the other hand, goat milk has a relatively low content of Vitamin E and folic acid (Amigo & Fontecha, 2011). The vitamin composition of goat milk is presented in table 5.

**Table 4.** The mean mineral composition of goat milk.

| Element (mg/kg) | Park *et al.*, 2007 |
|---|---|
| **Calcium (Ca)** | 1340 |
| **Potassium (K)** | 1810 |
| **Magnesium (Mg)** | 160 |
| **Sodium (Na)** | 410 |
| **Phosphorous (P)** | 1210 |
| **Sulphur (S)** | 280 |
| **Zinc (Zn)** | 5.6 |
| **Iron (Fe)** | 0.7 |
| **Manganese (Mn)** | 0.32 |
| **Copper (Cu)** | 0.5 |

**Table 5.** The mean vitamin composition of goat milk.

| Vitamin (mg/kg) | Park *et al.*, 2007 |
|---|---|
| **A** | 0.5 |
| **D** | 0.0006 |
| **E** | --- |
| **K** | --- |
| **C** | 12.9 |
| **Thiamine ($B_1$)** | 0.68 |
| **Riboflavin ($B_2$)** | 2.1 |
| **Niacin ($B_3$)** | 2.7 |
| **Pantothenic acid ($B_5$)** | 3.1 |
| **Vitamin $B_6$** | 0.46 |
| **Folic acid ($B_9$)** | 0.01 |
| **Biotin** | 0.015 |
| **Vitamin $B_{12}$** | 0.00065 |

## 3.5 Cow milk

The Mongolian cattle breed is a small, but hardy animal. There are also many mixed breeds with more exotic blood, such as Alatau, Simmental and white-faced Kazakh. The cattle in Mongolia are generally very poor milkers (Suttie, 2005), but may produce about 500-600 kg of milk in a five-month lactation period (www, the cattle site, 2013).

Approximate composition of milk of low land breeds is: 3.3% protein, 4.0% fat, 4.6% lactose and 0.7% minerals (Walstra *et al*., 1999). Ceballos *et al*., (2009) presented 11.4% solids, 2.8% protein, 3.4% fat, 4.5% lactose and 0.7% minerals of cow milk in their study and they emphasis the variation in the composition of milk depending on the breed, lactation stage, feed etc. Cow milk has almost a neutral flavour profile and it is a pleasantly sweet with no distinct aftertaste (Alvarez, 2009).

### 3.5.1 Milk fat

Cow milk lipids contain short-chain saturated fatty acids (butyric, propinic, acetic, valeric and isovaleric acid), long-chain saturated fatty acids (palmitic and stearic acid), monounsaturated fatty acids (mainly oleic acid *n*-9) and polyunsaturated fatty acids (linoleic acid n-6 and linolenic acid n-3) (Micinski *et al*., 2012). Saturated fatty acids made up approximately 70%, the monounsaturated fatty acids 27% and the polyunsaturated fatty acids 3% of total fatty acids in the milk. Cow milk fat is the main source of CLA in food. Total average CLA content in cow milk is approximately 0.43%, which was shown to be mainly cis-9, trans-11 (Devle *et al*., 2012).

The cow milk fat globule membrane (MFGM) has been considered as a potential nutraceutical, due to its many health beneficial components. One of the health benefits mentioned is its ability to inhibit cancer cell growth (Spitsberg, 2005). Tellez *et al*, (2012) showed evidence of the inhibitory effect of MFGM on the virulence of *E.Coloi*. This effect showed to be more pronounced with heat-treated MFGM fractions.

### 3.5.2 Proteins

Whole casein in cow milk consists of average 48.9% $\alpha_s$-casein, 36.5% β-casein, 12.% κ-casein and 2.1% γ-casein (Davies & Law, 1977). Cow milk has shown to be efficient against microbial infections in humans, due to its naturally occurring antibodies (immunoglobulin). Various studies regarding cow milk derived immunoglobulins and its antimicrobial effect against microbes has been performed and they have shown that orally administered cow milk immunoglobulins are effective in the prevention of orally mediated infections (El-Loly, 2007). Antibodies from cow milk have a role to play in human therapy (Weiner *et al*., 1999) and Freedman *et al*., (1998) give an example of how milk-derived immunoglobulins can protect against oral challenge with Enterotoxigenic *Escherichia coli* (a pathogen responsible for so called travel’s diarrhoea).

### 3.5.3 Minerals and vitamins

Cow milk is an important source of several minerals and vitamins and for many people it is a significant part of the diet completing the nutritional requirements. An example of the mineral composition of cow milk is indicated in table 6. This composition is considered to be relatively constant. However, depending on season, breeding, feeding and cattle management the milk composition undergoes continuous changes. (Lindmark-Månsson *et al*., 2003**)**. The most important vitamins in cow milk are the fat-soluble A and D together with the water-soluble vitamins tiamin ($B_1$), riboflavin ($B_2$) and $B_{12}$ (Andersen, 1993). An example of the vitamin composition of cow milk is presented in table 7.

**Table 6.** The mean mineral composition of cow milk.

| Element (mg/kg) | Lindmark-Månsson *et al*., 2003 |
|---|---|
| **Calcium (Ca)** | 1140 |
| **Potassium (K)** | 1600 |
| **Magnesium (Mg)** | 120 |
| **Sodium (Na)** | 400 |
| **Phosphorous (P)** | 900 |
| **Sulphur (S)** | ---- |
| **Zinc (Zn)** | 4.4 |
| **Iron (Fe)** | 0.4 |
| **Manganese (Mn)** | 0.1 |
| **Copper (Cu)** | 0.1 |

**Table 7.** The mean vitamin composition of cow milk.

| Vitamin (mg/kg) | Lindmark-Månsson *et al.*, 2003 |
|---|---|
| **A** | 0.3 |
| **D** | 0.0003 |
| **E** | 1.01 |
| **K** | 0.0041 |
| **C** | 11.6 |
| **Thiamine ($B_1$)** | 0.4 |
| **Riboflavin ($B_2$)** | 1.41 |
| **Niacin ($B_3$)** | 0.64 |
| **Pantothenic acid ($B_5$)** | 3.4 |
| **Vitamin $B_6$** | 0.42 |
| **Folic acid ($B_9$)** | 0.056 |
| **Biotin** | 0.011 |
| **Vitamin $B_{12}$** | 0.0041 |

## 3.6 Camel milk

Camels in Mongolia are of the two-humped type called Bactrian camel. A female camel produces approximately 8-10 calves during a lifetime and the lactation period can vary from 9-18 months (Farah, 2011). Good milking camels can produce 20 to 30 litres daily (Wernery, 2006). Camel milk is considered by the Mongolians to have unique nutritional and healing properties. It is used in Mongolia for example as a diuretic, to treat edema, to stimulate growth in children, to treat insomnia and to treat vitamin and mineral deficiencies (Indra, 2003). Camel milk is composed of approximately 11.7% total solids, 3.0% protein, 3.6% fat, 0.8% ash and 4.4% lactose (Sawaya *et al.*, 1984). Camel milk has a sweet and sharp taste. The taste generally depends on the type of feed and the amount of drinking water available (Farah, 2011). Nikkhah (2011) mentions that the unfavourable odour and taste of camel milk is a hinder for its spread and popularity. In a study by Hashim *et al.*, (2009) a low acceptability of yoghurt made from camel milk was observed. The low acceptability was mainly due to the distinct flavour of the product. However, when the camel milk yoghurt was flavoured with fruits or berries the acceptability score went up resulting in a more acceptable product.

### 3.6.1 Milk fat

The fat content in camel milk differs depending on the water content (Wernery, 2006) and it can vary between 2.9-5.4 % (Farah, 2011). Camel milk differs from other mammalians fat by its high content of the long-chain fatty acids C14:0, C16:0, C18:0 and C18:1 and its lower content of short chain fatty acids (Abu-Lehia, 1989, Konuspayeva *et al.*, 2008). The ratio of unsaturated/saturated fatty acids is more favourable in camel milk compared with cow and other mammalians milk. The essential fatty acid α-linolenic acid (C18:3) composition in camel milk was 10 times higher (0.6%) than in cow milk, which confers to the camel milk interesting nutritional properties. The cholesterol content of camel milk is 371 mg/kg. (Konuspayeva *et al.*, 2008). The total cis,trans CLA isomers in camel milk is around 1.6%-2.2%. Approximately 60 % of the total cis,trans CLA isomers was shown to be cis-9, trans-11, which equals 1.23g per 100 gram of camel milk (Dreiucker & Vetter, 2011).

### 3.6.2 Proteins

Camel milk is a rich source of proteins with potential antimicrobial activity (Kappeler, 1998). Casein is the major protein in camel milk. The two main caseins are the β-casein followed by αs1-casein. This ratio differs from cow milk where the β-casein content is much less. The higher levels of β-casein could reflect a higher digestibility rate. Only a low amount if *K*-casein is present in camel milk (Farah, 2011, Ochirkhuyag, 1997). *K–casein* is an important part of the curd forming process when making yoghurt (Tamime & Robinson, 1999). Camel milk β-casein may play an important role in promotion of health. Salami *et al*., (2011) showed that after enzymatic digestion, the β-casein in the camel milk act as natural antioxidant and ACE-inhibitors. This supports the use of camel milk caseins as anti hypertensive and antioxidant agents. The whey proteins in camel milk are different from that of cow milk and they are contributing to the high anti-bacteriological properties of the milk. Camel milk whey proteins are very heat stable. Heating the milk to 100°C did not have a strong effect on α-lactalbumin and β-lactoglobulin in the camel milk while the same heat treatment affected the α-lactalbumin and β-lactoglobulin in the cow and buffalo milk more severe. Also antimicrobial factors in camel milk are significantly present in higher concentration than in cow and buffalo milk and they have also shown to be more heat resistance than their counterparts in cow and buffalo milk. Camel milk has a very high concentration of lysozyme, lactoferrin and immunoglobulin if compared to cow and buffalo milk and they are much more heat stable (Elagamy, 2000). Camel milk has proven to be an interesting food for people allergic to cow milk. Camel milk contains a very minor pattern or even the absence of β-lactoglobulin (Elagamy, 2000, Elagamy *et al*., 2009, Hinz *et al*., 2012), which is a well know cow milk allergen (Wal, 1998). Elagamy *et al*., (2009) analyzed the proteins in human, cow and camel milk. They concluded that there is an absence of similarity between camel and cow milk proteins and camel milk might be a promising protein source for children allergic to cow milk protein. Similar results were confirmed by Hinz *et al*., (2012). Another study even indicated that camel milk could treat other food allergies by simply consuming the milk. Shabo *et al*., (2005) treated eight children suffering from food allergies (milk allergies were common to all) with camel milk. All children reacted well to the camel milk and they all recovered fully from their allergies.

### 3.6.3 Minerals and vitamins

Camel milk contains various minerals that are essential for the human body. The high content of iron in camel milk suggests that this milk is a good alternative to iron supplementation. (Al-Awadi & Srikumar, 2001). In table 8 the mean mineral composition of camel milk is presented.

Camel milk also contains many various vitamins, such as riboflavin, niacin, pantothenic acid, vitamin B-6, vitamin B-12, vitamin C, vitamin A and vitamin E (Kappeler, 1998). A study performed by Mehaia (1994) showed that camel milk contains two times more vitamin C than that of cow, goat or ewe milk. Table 9 shows the mean vitamin composition of camel milk.

**Table 8**. The mean mineral composition of camel milk

| Element (mg/kg) | Sawaya *et al.*, 1984 |
|---|---|
| **Calcium (Ca)** | 1060 |
| **Potassium (K)** | 1560 |
| **Magnesium (Mg)** | 120 |
| **Sodium (Na)** | 690 |
| **Phosphorous (P)** | 630 |
| **Sulphur (S)** | ---- |
| **Zinc (Zn)** | 4.4 |
| **Iron (Fe)** | 2.6 |
| **Manganese (Mn)** | 0.2 |
| **Copper (Cu)** | 1.6 |

**Table 9**. The mean vitamin composition of camel milk.

| Vitamin (mg/kg) | Sawaya *et al.*, 1984 |
|---|---|
| **A** | 0.15 |
| **D** | 0.016** |
| **E** | 0.54* |
| **K** | --- |
| **C** | 23.7 |
| **Thiamine ($B_1$)** | 0.330 |
| **Riboflavin ($B_2$)** | 0.416 |
| **Niacin ($B_3$)** | 4.61 |
| **Pantothenic acid ($B_5$)** | 0.88 |
| **Vitamin $B_6$** | 0.523 |
| **Folic acid ($B_9$)** | 0.0041 |
| **Biotin** | ---- |
| **Vitamin $B_{12}$** | 0.0015 |

*Adapted from Farah *et al.*, 1992
**Adapted from Zhang *et al.*, 2005

## 3.7 Aaruul

Aaruul is a traditional Mongolian milk-based product. The process used to make aaruul include making tarag (the Mongolian version of yoghurt) and then drying the curd in the sun (Takeda *et al.*, 2011a). The result is a hard dried "cheese". The hardness of the cheese can be compared as about six times harder than a peanut (Amarsaikhan *et al.*, 2002), but it may vary depending on the ingredients and the process. Aaruul is consumed mainly as a snack. This type of cheese is not unique for Mongolia. Products similar to aaruul are afig in the Middle East, qurut in Afghanistan and Pakistan and churppi in Nepal (Degen, 2007). There is not much information or documented research performed on aaruul. However, a study carried out by Karvonen *et al*. (2007) where the eating habits of Mongolian children in relation to their dental health was investigated, showed that children that ate aaruul often had fewer cavities and more proper dental health than other children. In a study by Takeda *et al*., (2011a) the probiotic potential of lactic acid bacteria isolated from traditional Mongolian dairy products was investigated. Lactic acid bacteria are considered to be probiotics with properties beneficial to health. This study suggests that the heat treatment the tarag (yoghurt) goes through (boiling and drying) when making aaruul kills off the lactic acid bacteria from the tarag (yoghurt) and therefore the lactic acid bacteria found in aaruul are of environmental-origin. Lactic acid bacteria strains found in aaruul includes *L. plantarum* (Takeda *et al*., 2011a, Takeda *et al*., 2011b), which is know for its health benefits such as offering digestive support and promoting healthy cholesterol levels (Corsetti & Valmorri, 2011).

### 3.7.1 Yoghurt

One of the most critical and important steps in the making of aaruul is the production of yoghurt. To set up yoghurt production, the milk is treated in order to create an optimal environment for the starter culture. The milk is standardized and homogenized to get a uniform product. The milk is also deaerated in order to avoid whey separation and imperfect consistency, such as a grainy and a runny product. To destroy the bacteria that could compete with the starter culture the milk is pasteurized. The pasteurization is a critical part of the processing of yoghurt and it is performed with the aim of:

- destroying bacteria to remove competition for the starter culture
- break down inhibitory substances in the milk to create an optimal growing environment for the culture
- denaturize the whey proteins in order to give the product a thick and stable consistency
- lower the amount of dissolved oxygen, which could be inhibitory for the starter culture

After the heat treatment the milk is cooled down to about 40-45°C and the starter culture is added and the product is fermented usually between 3-8 hours (Andersen, 1993).

#### *3.7.1.1 Yoghurt based on different milk sources*

The milk source impacts the rheological properties of yoghurt during the gelation process. The total solids and protein content of the milk influence the viscosity of the yoghurt. The viscosity is higher for milk with high amount of total solids and protein. Goat, cow and yak has similar viscosity and incubation time when producing yoghurt, while camel milk has no notable variation in viscosity with incubation time (Jumah *et al*., 2001). Various authors have investigated the curd formation in camel milk and it appears that yoghurt made from camel milk tends to form a watery consistency (El Zubeir *et al.*, 2012, Hashim *et al.*, 2009). The ability for dromedary skim milk to form an acid curd during lactic acid fermentation was investigated by Attia *et al.*, (2001). The study showed that the dromedary milk had an inability to form a lactic acid curd and this was explained by the presence of inhibitory factors in the milk or the mineral and/or the casein composition of its colloidal phase. A study performed by Hassan *et al.*, (2007) also described that camel milk was hard to ferment and concluded that the total bacteria counted had a minimum rate of growth at the beginning of the incubation time. Rahman *et al*., (2009), obtained similar results as above. However they tried different starter cultures and observed a slight difference in growth and acid production, but all fermented camel milk trials resulted in a product with watery and fragile, poor structure. Yoghurt made of horse milk has also shown to have a very low viscosity. In a study by Di Cagno *et al*., (2004) yoghurt made from pure horse milk had a very low viscosity and results from a sensory evaluation gave it rather poor scores in terms of appearance, consistency and taste. However, by mixing it with cow milk, sheep milk or Na-caseinate increased the concentrations of caseins, which resulted in yoghurt with higher viscosity.

There are many inhibitors in milk that may hinder fermentation by dairy starters. Added substances, such as antibiotics or detergent residues, may inhibit dairy starters. Free fatty acids can be produced due to high activity of milk lipase or microbially produced lipase and they are inhibitory to some starter cultures. Also natural indigenous antimicrobial proteins, such as immunoglobins, lysozyme, lactoferrin and vitamin binding proteins are effective inhibitors (Mullan, 2003).

### 3.8 Whey

The liquid residue from production of aaruul is called acid whey. Whey contains about 50% of the nutrients in the original milk: soluble protein, lactose, vitamins and minerals (Bylund, 1995). Whey is also a good source for lactose derivates, such as lactulose, lactitol and oligosaccharides (Horton, 1995). Table 10 shows the approximate composition of acid whey.

**Table 10.** Approximate composition of acid whey, %. (Bylund, 1995)

| Constituent | Acid whey (%) |
|---|---|
| **Total solids** | 6.5 |
| **Water** | 93.5 |
| **Fat** | 0.04 |
| **Protein** | 0.55 |
| **Lactose** | 4.9 |
| **Calcium (Ca)** | 0.12 |
| **Phosphorous (P)** | 0.065 |
| **Sodium (Na)** | 0.05 |
| **Potassium (K)** | 0.16 |
| **Chloride (Cl)** | 0.11 |

Nergiz & Seçkin, (1998) investigated the loss of nutrients when producing strained yoghurt. They found that the highest losses were lactose and minerals. The average losses of minerals were: sodium 70.2%, potassium 68.2%, calcium 65.6% and phosphorus 50.2%. The amount of fat passed from yoghurt to whey was on average 0.78%, which indicated that nearly all of the fat was retained in the yoghurt curd. The water-soluble vitamins thiamine and riboflavin were found in the whey at an average of 51.8 % and 60.5% respectively.

### 3.9 "Super berries"

”Super fruits” and ”super berries” are popular terms describing a fruit or a berry with remarkable health benefits. Gojiberries and sea buckthorn are two of the berries fitting into that description and both grow in Mongolia.

#### 3.9.1 Sea buckthorn

Sea buckthorn is small berry-like fruits that come from the plant *Hippophae rhamnoides L.* The berries are yellow-orange in colour and their flavour has been likened to a combination of passion fruit and pineapple, but a bit too acidic to eat fresh. Sea buckthorn berries are known to be among the most nutritious and vitamin rich berries of all berries with exceptionally high content of antioxidants (Li & Beveridge, 2003). In a review by Kumar *et al.*, (2011) the phytochemical and pharmacological profile of the sea buckthorn was presented. The sea buckthorn oil was reported to have anti-inflammatory, antioxidant, anti-microbial, anti-ulcer and hepatoprotective (ability to prevent damage to the liver) properties. The berries are a good source of vitamins and minerals and they contain Vitamin C, Vitamin A, Vitamin E, Riboflavin, Niacin, Panthothenic acid, Vitamin B6, potassium, calcium, iron, magnesium, phosphorus, sodium, zinc, copper, manganese and selenium (Kumar *et al.*, 2011). By consuming sea buckthorn as a nutritional supplement it can help to maintain a normal balance of most of the ions (Stobdan *et al*, 2010).

The berries also contain 5-hydroxytryptamine, which acts as a neurotransmitter and therefore regulate human emotion, blood pressure, body temperature and hormone levels. 5-hydroxytryptamine is also known to have antiradiation, anti-infection and anti-cancer functions. The berries also contain the healthy and essential families of fatty acids n-3 and n-6. Sea buckthorn is the only seed oil that naturally provides a 1:1 ratio of n-3 (linolenic acid) to n-6 (linoleic acid), which is beneficial for human health (Kumar *et al.,* 2011, Fatima *et al.,* 2012).

### 3.9.2 Gojiberry

Gojiberry is the fruit of *Lycium barbarum L*. or its closely related specie *Lycium Chinese*. The berries have many names, but the most widely used is gojiberry or wolfberry. The small (1-2 cm) bright orange-red berries grow on clambering, woody perennial shrubs. Some species have spines, other do not. Traditional use of the berry has been described in Chinese folk medicine and the berry has been used to lower cholesterol and blood pressure, to treat kidney disease, to improve vision and eye disease and to increase longevity. Gojiberries have a similar flavour to that of dates, dried cranberries or raisins, but more pungent, less sweet and with an herbal scent (Badenes & Byrne, 2012).

The gojiberry is a valuable source of bioactive compounds and it has been suggested as a novel functional ingredient for the prevention or treatment of chronic diseases. Polysaccharides derived from gojiberries have shown to have various important bioactivities, such as immunomodulation, antitumor, neuroprotection, radioprotection, anti-diabetes, hepatoprotection, anti-osteoporosis and antifatigue. However, better understanding of the functional effects about this macromolecule is required, but the findings show a promising health food (Jin et *al*., 2013). Also carotenoids and flavonoids are found in plenty in gojiberries and they both possess antioxidant activity. The flavonoid fraction in gojiberries is very effective in scavering free radicals, chelating metal ions and reducing power (Wang *et al*., 2010). Gojiberries also contain various vitamins and minerals, such as thiamine, riboflavin, niacin, vitamin B6, vitamin C, vitamin E, zinc, iron, copper, calcium, selenium, and phosphorus (Tang *et al*., 2012).

### 3.9.3 Drying of fruits – effect on nutrients

Fruit undergo changes during drying, which reduces their quality compared to the fresh material. The drying affects the texture, flavour, colour and nutritional value of the fruit. The loss in nutritional value of dried fruit is due to wide variations in the preparation procedures and the drying temperature and time etc. The loss of some of the vitamins in fruit when dried is in general 6% of vitamin A, 55% of thiamine, 10% of niacin and 56% vitamin C. The fat-soluble nutrients (essential fatty acids and vitamin A, D, E and K etc.) are mostly contained within the dry-matter of the food. However, as water is removed the oxidation in the food accelerates, resulting in the loss of some fat-soluble vitamins, due to the interaction with peroxides produced by fat oxidation (Fellows, 2003). Fruit also contains large amount of antioxidants, such as flavonoids. The amount and quality of phenol antioxidants in dried fruits were compared with the corresponding fresh fruits by Vinson *et al*., (2005). They concluded that the quality of the antioxidants in the dried fruit was the same as in the corresponding fresh fruit. However, processing to produce the dried fruit significantly decreases the phenols in the fruits on a dry weight basis.

## 3.10 Milk products and Mongolia

Milk is a staple and a sacred food in Mongolia and the livelihoods and wellbeing of the Mongolian people depends mainly on livestock and on milk in particular. Nomadic herding and the making of traditional dairy products are at the core of the Mongolian society providing a big share of national income and employment. Mongolia was self sufficient in milk up to 1990 when the dairy industry collapsed, due to the rapid transition to the market economy. This worsened the food insecurity and the import increased. By the late 1990s Mongolia was importing three quarters of its dairy products. The country has a huge animal resource base and vast range lands and therefore has the capacity to produce all its milk and to export any surplus. 22 percent of the country comprises of grasslands and pesticides and other chemicals are rarely or never used. Mongolia has therefore a potential international advantage for producing "clean" milk under extensive conditions. There are initiative for milk production enhancement programmes in Mongolia in order to produce quality milk using good farming practices for enhanced rural incomes and responsible steppe management (Dugdill, 2007).

# 4. Results

The potential health aspects of milk from cow, yak, horse, goat and camel and the berries of sea buckthorn and goji are presented in the theory background and will be further discussed under section 5 (see also Appendix C for a summary of the mineral and vitamin content for the various milk sources). The findings regarding the feasibility to produce aaruul from cow, yak, horse, goat and camel milk and the results from the acceptance test will be presented in this section.

## 4.1 Aaruul

All trials were performed in accordance to the method presented, except for aaruul based on camel milk, which had to be incubated at 43°C for 20 hours instead of 4 hours. The camel milk never formed a thick curd and stayed relatively watery even after 20 hours at 43°C after being inoculated with the starter culture. The horse milk never formed a curd, not even after 48 hours at 43°C after being inoculated with the starter culture and therefore it had to be excluded from the acceptance test. Milk from cow, yak and goat formed a thick curd after 4 hours at 43°C and the aaruul yield was relatively high. Even though the camel milk never formed a stable curd, it was thick enough to de-whey and produce aaruul of. However, the aaruul yield from the camel milk was slightly smaller than from yak, goat and cow. During the drying process it was observed that a small amount of fat leaked out of all the different samples of aaruul.

All aaruul samples were based on pure milk, which was turned into yoghurt and then de-wheyed and dried. Nothing (additives, sugar etc.) was added to the products, except two samples, which were flavoured with berries.

## 4.2 Acceptance test

Six samples of aaruul (based on cow milk, yak milk, goat milk, camel milk, cow milk with the addition of dried sea buckthorn and cow milk with the addition of dried gojiberries) were included in the acceptance test. No aaruul based on horse milk were included, due to the demonstrated inability of horse milk to form a curd when fermented. A total of 76 consumers participated in the study and they included a mix of nationalities from Australia, Belarus, Belgium, Canada, China, Cuba, Czech Republic, France, Germany, Indonesia, Ireland, Italy, Japan, Kazakhstan, Mexico, Netherlands, Peru, Poland, Romania, Russia, South Korea, Spain, Sweden, Ukraine, United Kingdom and USA. 68% of the participants were male and 32% were female and the age ranged from 26 to 68 years old. All participants were regular consumers of both yoghurt and cheese. The result of the acceptance test is presented in figure

1 and the means values and standard deviation for the different samples are presented in table 11.

**Figure 1.** Acceptance test aaruul. The y-axis shows the number of ballots the aaruul samples have received on the different steps on the hedonic scale.

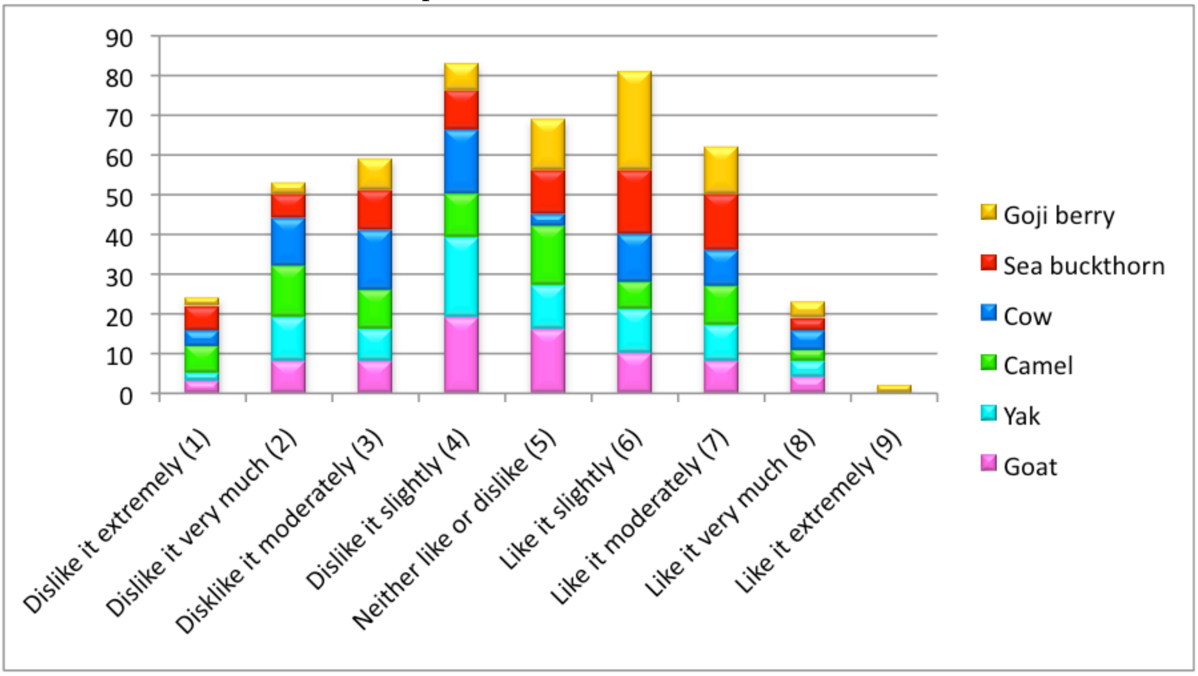



**Table 11.** Mean values and standard deviation of the different aaruul samples included in the acceptance test.

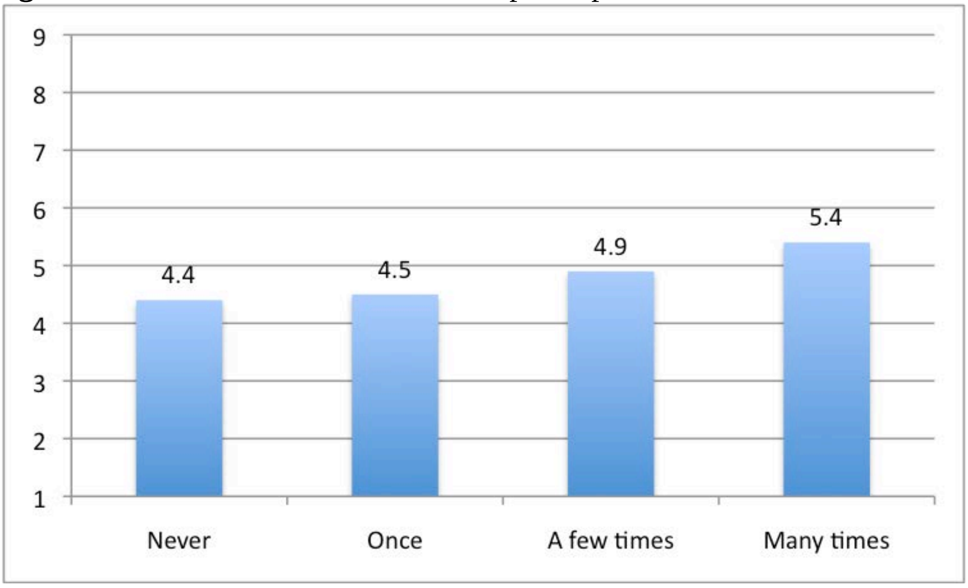
| Aaruul | Mean | Std. Dev. |
|---|---|---|
| **GOAT** | 4.57 | 1.77 |
| **YAK** | 4.53 | 1.82 |
| **CAMEL** | 4.18 | 2.01 |
| **COW** | 4.3 | 2.01 |
| **SEA BUCKTHORN** | 4.75 | 1.98 |
| **GOJIBERRY** | 5.38 | 1.74 |

Figure 1 shows the distribution of answers from the acceptance test. The mean values (see table 11) show that the aaruul based on cow milk with the addition of dried gojiberries had the highest acceptance of the six samples with a mean of 5.4, which translates to a mean between "*neither like or dislike*" and "*like it slightly*". The least accepted was the aaruul based on camel milk, which had a mean of 4.2 (closest to "*dislike it slightly*"). Furthermore, aaruul based on cow milk with the addition of dried sea buckthorn had a mean value of 4.8 (closer to "*neither like or dislike*"), aaruul based on goat milk had a mean value of 4.6 (between "*dislike it slightly*" and "*neither like or dislike*"), aaruul based on yak milk had a mean value of 4.5 (between "*dislike it slightly*" and "*neither like or dislike*") and aaruul based on cow milk had a mean value of 4.3 (between "*dislike it slightly*" and "*neither like or dislike*"). The few comments from the participants during the test were that they overall did not find the product palatable, many found the flavour of the product very “acidic”/”too tangy” and a few mentioned that they preferred the berry flavoured aaruul due to a sweetness in the product.

The ANOVA test showed a significant difference between the samples. At a significance level at 5% ($P < 0.05$) the aaruul based on cow milk with the addition of dried gojiberries showed to have a significantly higher acceptability compared to the other samples. At a significance level at 10% ($P < 0.1$), also aaruul based on cow milk with the addition of dried sea buckthorn and aaruul based on camel milk showed a significant difference.

The participants included in the acceptance test were asked if they had tried aaruul before. The results showed that 46% answered “never”, 22.5% answered “once”, 17% answered “few times” and 14.5% answered “many times”. The mean values of the overall liking of the six samples included in the test divided into the four categories “never”, “once”, “a few times” and “many times” are presented in figure 2.

**Figure 2.** Mean values of how often the participant tried aaruul before




# 5. Discussion

## 5.1 Aaruul from different dairy sources

The milk has to form a curd in order to make aaruul. The trials confirmed that the milk source impacts the rheological properties of yoghurt during the gelation process and therefore affects the possibility to make aaruul.

The viscosity of the yoghurt is higher for milk with high amount of total solids and protein (Jumah *et al*., 2001). This was confirmed, as the horse milk, which has the lowest total solids and protein, never formed a curd when incubated with starter culture. However, it could be possible to make aaruul out of horse milk by mixing it with milk from other animals or Na-caseinate in order to increase the concentrations of caseins, as suggested by Di Cagno *et al*., (2004). This was not undertaken in this study, but could be a recommended trial, if making aaruul out of horse milk. Yak, goat and cow milk formed a firm and stable curd and could therefore produce a relatively large quantity of aaruul. The camel milk never formed a thick curd and stayed relatively watery even after 20 hours at 43°C after being inoculated with the starter culture. Camel milk has lower total solids and protein than yak, goat and cow milk and this could be one reason for camel milk not forming as stable curd as milk from yak, goat and cow. However the results are in accordance with Attia *et al.*, (2001), El Zubeir *et al.*, (2012), Hassan *et al.*, (2007), Hashim *et al.*, (2009), Jumah *et al*., (2001) and Rahman *et al*., (2009) who also found camel milk hard to ferment and lacking the ability to form a curd. Attia *et al.*, (2001) explained this fact with a presence of inhibitory factors in the milk or the mineral and/or the casein composition of its colloidal phase. Another explanation for the watery consistency of the camel milk curd could be the low amount of *K*-casein present in the camel milk. Since *K*–casein is an important part of the curd forming process when making yoghurt. Even though the camel milk never formed a stable curd, it was thick enough to de-whey and produce aaruul out of.

## 5.2 Acceptance test

Aaruul is a relatively unknown product outside Mongolia and its tangy flavour and hard texture is unfamiliar for many. Aaruul, which is a very popular and well-known product among Mongolians, is a totally new food for many markets. In order to get an indication if consumers other than Mongolians could accept this product, an acceptance test was performed on parts of the international community in Mongolia. An acceptance test provides some information on whether the product is liked or disliked in some absolute sense. Since aaruul is widely consumed in Mongolia the participants in the acceptance test included both consumers that had tried aaruul and those who had never tired aaruul before. Since this is a pilot study and the market for aaruul is not determined the focus was set on to get an overall understanding of the liking of aaruul. Different types of aaruul was tested on the consumers in order to investigate if a certain milk source was more preferred than others or if the addition of Mongolian native berries could make the product more palatable. The sample size in the acceptance test was 76. This is a relatively small sample size, but it should cover for most tolerable levels of risk (Lawless & Heymann, 2010). A bigger sample size would have given a more powerful test. However, the results still gave an indication on the acceptance of the product. The ANOVA results indicated that there is a significant difference in liking between the different aaruul samples. Aaruul based on cow milk with the addition of dried gojiberries differed from the other samples at a significance level at 5%. This aaruul had the highest acceptance of the six samples with a mean of 5.4, which translates to "*neither like or dislike*" to "*like it slightly*". Even though aaruul with gojiberries had the highest liking among the participants, the product still only reached between "*neither like or dislike*" and "*like it slightly*" on the hedonic scale. This indicates that the most liked aaruul sample is still only moderately liked by the consumers. The addition of gojiberries adds sweetness to the product and it is possible that this sweetness balances the tanginess and makes this aaruul more palatable than the other samples. The addition of sugar might have similar effect, but would lower the health beneficial effect of the product. At a significant level of 10% aaruul based on camel milk and aaruul based on cow milk with the addition of sea buckthorn also differed from the other samples. The aaruul based on cow milk with the addition of sea buckthorn berries was second most liked of the six samples. Sea buckthorn is very acidic in its flavour and therefore do not extensively reduce the tanginess in the product. On the contrary, it can be assumed that it adds on to the sourness of the aaruul. However sea buckthorn adds a pleasant fruity flavour to the product. The aaruul based on camel milk had the lowest acceptability score. Camel milk has a distinct flavour and this flavour is notable present in the product. This flavour is unfamiliar for anyone not used to consume camel milk. It could therefore be expected that aaruul based on camel milk is less accepted by consumers unaccustomed to camel milk.

It is recommended that the participants in an acceptance test should be regular users of the product, i.e. belong to the target market or at least like or be familiar with the type of product that is tested (Lawless & Heymann, 2010). However, aaruul is a new product for most non-Mongolians and the majority of the potential market is unfamiliar with this type of product. All participants regularly consumed both yoghurt and cheese, which could be considered to be similar products to aaruul. As the acceptance test was performed on parts of the international community in Mongolia, some of the participants had tried aaruul either once, a few times or many times before. The mixed results of "never", "once", "a few times" and "many times" gave an interesting perspective to the study. In general it could be assumed that anyone who choose to consume a product a few times or more have developed a form of liking for the product. Therefore could it be expected that the participants that had tried aarrul many times before would have a higher mean value than 5.4, which translated to a liking between "*neither like or dislike*" and "*like it slightly*". The results show that there is a tendency for a higher liking the more times you have consumed aaruul, but the correlations are not highly significant. However, it is important to mention that aaruul is often offered to guests in Mongolia when visiting a Mongolian home etc. As a guest in a foreign culture you might choose to eat the product even though you find it less palatable. This is important to consider when interpreting the results regarding the frequency of eating aaruul and the degree of liking. This indicates that the participants that had never tried aaruul before did not significantly lower the overall liking for the aaruul nor did the participant that had tried aaruul before significantly raise the overall liking for the aaruul. The results also indicated that the liking of aaruul is not raised considerably the more times you consume the product. On the other hand it is important to note that the distribution of participants between the different frequency categories were not evenly distributed and the results may look slightly different if the different categories had a higher and the same amount of ballots.

The age, gender and nationality have not been deeply reflected upon in this study, due to the target market not being determined. The aim of the test was to find out how aaruul is received by non-Mongolians and no age, gender or nationality was therefore preferred over another. The test served its purpose and gave an indication of the liking of aaruul by non-Mongolians. However it is important to stress that no conclusions can be drawn about any particular market. This study simply gives an overall indication of how aaruul is accepted by a mix of nationalities recruited from the international community in Mongolia and it does not exclude that there may be other markets that will give totally different results on a similar test.

## 5.2 Health aspects

The main raw material in aaruul is milk. The high nutritional and health value of milk is well known. Milk is not only an important source of calcium, protein, zink, magnesium and vitamins, but it has also shown to have health promoting properties. Milk contains numerous bioactives that function beyond their nutritional value. However, in the process of making aaruul, some nutrients are lost due to for example; heating of the milk, de-wheying the curd and drying the product in the sun. Heating has some effect on the nutritional value of milk. For example, heating reduces the antioxidant activity, such as the loss of vitamin C (Bylund, 1995, Calligaris *et al*., 2004). However it is important to stress that the heating of milk increases the microbial safety without substantially changing the nutritional value of the milk (Claeys *et al*., 2013) and the heating it is also vital in order to create an optimal environment for the starter culture. The choice of heat treatment should be considered in order to achieve the purpose of the heating (inactivation of pathogens, break down inhibitory substances etc.), but also reduce the negative effect of the heat on the nutritional value. In the process of making aaruul, all the whey is removed from the product. Whey contains various nutrients, such as soluble protein, lactose, vitamins and minerals. Therefore it could be assumed that aaruul has a lower nutritional value in terms of protein, lactose, vitamins and minerals then its raw material. However, the loss of lactose is an advantage for those who suffer from lactose intolerance. According to tradition, aaruul should be dried in the sun. Mongolians generally dry the aaruul on the top of their yurt in the sun and air. However, light exposure has shown to affect the nutritional values of the milk in a negative way. Studies by Whited *et al*., (2002) and Saffert *et al*., (2006) demonstrated a loss of vitamins (retinol and riboflavin) when milk was exposed to light. Mortensen *et al*., (2004) mentioned loss in nutritional value when exposing cheese to light, but they also pointed out that the light form toxic products (e.g. cholesterol oxides) in the cheese. These results indicate that drying aaruul in the sun has negative effect on the nutritional value of the product. In order to avoid loosing nutrients and forming toxic products in the aaruul, other ways of drying the product should be considered. It was also observed that a small amount of fat leaked out of the product during the drying process. It can therefore be concluded that aaruul has a lower fat content than its raw material. Aaruul will therefore probably also loose some of the di- and monoglycerides, sterols, carotenoids, vitamins (A, D, E and K) and minor trace elements in the drying process. Another factor that affects the fat-soluble nutrients (essential fatty acids and vitamin A, D, E and K etc.) is when water is removed from the product the rate of oxidation accelerated due to more reactive catalysts. The fat-soluble nutrients interact with peroxides, which are produced by fat oxidation (Fellows, 2003). This reaction can be expected to occur in aaruul and it will reduce the total fatty acids and vitamin A, D, E and K.

Even though some nutrients are lost in the process of making aaruul, it still has the potential of being a healthy product. One important health aspect of milk is its ability to protect the teeth from the demineralization process. Drinking milk or eating cheese has shown to protect against dental caries (Johansson, 2002, Moynihan *et al*., 1999). Even aaruul has demonstrated to increase dental health (Karvonen *et al*. 2007). These studies indicate that aaruul also could possess health benefits when it comes to the protection against caries. Some minerals are lost during the de-wheying and drying process. 68.2% of total potassium and 65.6% of total calcium was found in whey when producing strained yoghurt (Nergiz & Seçkin, 1998) and similar amount can be assumed to be lost in the production of aaruul. However aaruul is still likely to be a significant source of calcium, which is an important mineral in the formation of bones. It is also likely to be a good source of potassium and magnesium. It is relatively uncertain to elaborate if aaruul could be a good source of vitamins. A large amount of the water-soluble vitamins are most likely lost in the process of making aaruul. Since nearly all fat is retained in the curd (Nergiz & Seçkin, 1998) it could be assume that most of the fat-soluble vitamins in the milk are still present in the aaruul. Except from vitamins, the milk fat contains many other healthy substances. Small amounts of the essential fatty acids $\alpha$-linolenic acid and linoleic acid might be present in the product, due to their presence in milk. Conjugated linoleic acid (CLA) is found in various amounts in milk and it has many beneficial health effects, such as decrease body fat mass (Gaullier *et al*., 2005), enhance immune functions (Bassaganya-Riera *et al*., 2002) and inhibiting breast and lung cancer cell lines (Parodi, 1997). If present in the milk it could be assumed that this healthy substance also is present in aaruul. Even though many proteins (mainly the water soluble whey proteins) are lost in the de-wheying and drying process, aaruul still contains important proteins with health beneficial potential.

It is important to stress that the health aspects of aaruul in this study is assumptions based on the literature and it is recommended to further investigate the health aspects of aaruul. It is therefore suggested to have aaruul analyzed for its nutritional value and its health promoting properties.

### 5.2.1 Different types of milk

The aaruul in this study was based on milk from five different animals (cow, yak, horse, goat and camel) and Mongolian local berries (sea buckthorn and goji) were added in two of the samples based on cow milk. These different versions of aaruul contribute to various health aspects of the product.

It is important to stress that the milk composition data in this study was obtained from sources that were not mainly exclusive for Mongolia, due to the lack of data from Mongolian dairy producing animals. Naturally there is a variation in the composition of milk depending on the breed, lactation stage, feed etc. and the data from the literatures varies depending on seasonal variation, geographical variation, sample size, analytical procedures etc. However the data gives an overall indication of how the composition of milk differs between the animals under study.

#### *5.2.1.1 Yak milk aaruul*

Yak milk has a high fat content (5.5-7.2%) and the fat composition in yak milk is interesting from a health perspective. The amounts of *cis-9, trans*-11 CLA and *trans*- 11-C18:1 and n-3 polyunsaturated fatty acids are relative high (Or-Rashid *et al*., 2008) and these fatty acids could support aarruul based on yak milk as a potential healthy food product. Also yak milk casein appears to be interesting from a health perspective. The yak milk caseins have shown to possess an inhibitory activity of angiotensin-I-converting enzyme. These kinds of inhibitors are important for the treatment of hypertension (Mao *et al*., 2007), which adds another noteworthy health aspect to aaruul based on yak milk. Data for vitamins in yak milk were absent in the literature. However, due to the high fat content in yak milk, the concentration of the fat-soluble vitamins can be expected to be slightly higher in aaruul based on yak milk compared to the other aaruul samples in this study. If comparing the mineral composition of the different milks included in this study, aaruul based on yak milk can be expected to contain a slightly higher content of calcium and zinc. The copper content is higher in yak milk than horse, goat and cow milk, but lower than camel milk.

#### *5.2.1.2 Horse milk aaruul*

Even though this study demonstrated that horse milk do not form a curd after the incubation with starter culture it will be included as a possible raw material to make aaruul from, due to the study by Di Cagno *et al*., (2004) where they show that horse milk has the technological suitability to produce fermented milks if fortified with Na-caseinate etc.

Horse milk has a low fat content (2%). It has a high concentration of polyunsaturated fatty acids and one of the most abundant fatty acid is $\alpha$-linoleic acid (Minjigdorj *et al*., 2012). The low fat content and the high amount of the healthy fatty acids makes horse milk a favourable raw material to use for aaruul in regards health. However, the low amount of CLA in horse milk is a disadvantage from a health perspective. Proteins in horse milk do not react strongly with human IgE (Businco *et al*., 2000), which could make aaruul a suitable substitute for cow milk in cases of severe IgE-mediated cow milk allergy. The mineral content in horse milk is lower compared to the other milk sources included in this study. Aaruul based on horse milk can therefore be assumed to contain a low level of minerals. In terms of vitamins, horse milk has a relatively high content of vitamin C and E. However, the horse milk does not reach the high vitamin C level that is found in camel milk.

### 5.2.1.3 Goat milk aaruul

Goat milk has also many interesting characteristics as a raw material for aaruul. The high levels of medium-chain triglycerides in the goat milk have demonstrated to reduce the level of cholesterol in the body (Alférez *et al*., 2001, Lopéz-Aliaga *et al*., 2005). Goat milk also contains a reasonably amount of CLA. Both the high levels of medium-chain triglycerides and the CLA content add to the health beneficial effect of aaruul based on goat milk. The goat milk oligosaccharides have shown to possess anti-inflammatory effects (Daddaoua *et al*., 2006, Villoslada *et al*., 2006). However it is difficult to determine how much oligosaccharides are left in aarrul, due to the fact that whey has been identified to be a good source of oligosaccharides. On the assumption that some oligosaccharides are left in aaruul it would be an additional health aspect for aaruul based on goat milk. Goat milk contains the highest level of potassium, magnesium, phosphorous and manganese compared to the other milk sources included in this study. Goats convert all carotene into vitamin A (Amigo & Fontecha, 2011) and it can therefore be assumed that aaruul based on goats milk contain a relatively high amount of vitamin A. Also the water-soluble vitamins thiamine and riboflavin can be assumed to exist in a higher amount in goat aaruul than in aaruul from the other animals included in this study.

### 5.2.1.3 Cow milk aaruul

Cow milk is an excellent source of CLA (Devle *et al*., 2012) and it also contains a small amount of the polyunsaturated fatty acids linoleic acid and linolenic acid (Micinski *et al*., 2012). Another important fat related health aspect of cow milk is its content of milk fat globule membrane (MFGM), which has potential nutraceutical ability (Spitsberg, 2005, Tellez *et al*, 2012). Aaruul based on cow milk could therefore also be assumed to contain linoleic acid and linolenic acid, to be an important source of CLA and also possess similar nutraceutical ability as MFGM contributes to in cow milk. Cow milk is naturally a good source of vitamins and minerals. However, compared to the other milk sources included in this study, cow milk only characterizes itself slightly when it comes to pantothenic acid, folic acid and vitamin $B_{12}$.

### 5.2.1.4 Camel milk aaruul

Camel milk has many interesting nutritional properties and some of them are probably also found in camel milk based aaruul. The milk has a health favourable content of fatty acids and it has a relatively high level of $\alpha$-linolenic acid (Konuspayeva *et al*., 2008). It also contains CLA. Similar health favourable properties of the camel milk fat could be assumed to also be present in aaruul based on camel milk. The protein fraction in camel milk also has interesting health promoting features. The whey proteins have high anti-bacteriological properties (Elagamy, 2000), but much is lost during the de-wheying and drying of the product. The casein proteins ($\beta$-casein), which are found in higher amount in aaruul, acts as a natural antioxidant and ACE-inhibitor after enzymatic digestion. Camel milk is a promising protein source for people allergic to cow milk protein (Elagamy *et al*., 2009) and it has even indicated to be a treatment for other food allergies by simply consuming the milk (Shabo *et al*., 2005). It can be assumed that aaruul based on camel milk could be a promising dairy source for people allergic to cow milk protein or even an aid to reduce symptoms from other allergies. Camel milk contains various minerals and vitamins that are essential for the human body and aaruul based on camel milk could also be an important vitamin and mineral source. Camel milk appears to contain a high amount of iron, especially when compared to the other milk sources included in this study. Aaruul based on camel milk could therefore be assumed to be a good alternative to iron supplementation. Vitamin C is found in a large amount in camel milk, but some of it is lost during the process of making aaruul. Vitamin D, niacin and vitamin $B_6$

could also be assumed to be present in a higher amount in aaruul based on camel milk compared to the other aaruul types included in this study.

#### *5.2.1.5 Sea buckthorn flavoured aaruul*

Sea buckthorn is a berry-like fruit that is packed with nutrients and antioxidants. Even though the berry looses some of its important nutrients and antioxidant activity during the drying process, it will still be able to add much nutrition and high quality antioxidants to the aaruul. The aaruul based on cow milk with the addition of sea buckthorn can therefore be assumed to contain more health beneficial substances than the plain aaruul samples in this study. Besides a higher level of minerals and vitamins, the sea buckthorn flavoured aaruul will presumably also possess some of the phytochemical and pharmacological profiles that the fresh sea buckthorn holds. The level of linolenic acid and linoleic acid will also be somewhat higher in this aaruul compared to the other aaruul samples included in this study. The berry will also protect the milk during the sun drying process. It will protect the photodegradation on riboflavin and furthermore reduce the off-flavours in the milk.

#### *5.2.1.6 Gojiberry flavoured aaruul*

Gojiberry is another highly nutritious berry. Even though the berry looses some of its important nutrients and antioxidant activity during the drying process, it will still be able to add much nutrition and high quality antioxidants to the aaruul. The aaruul based on cow milk with the addition of gojiberry can also be assumed to contain more health beneficial substances than the plain aaruul samples in this study. The berry will protect the milk during the sun drying process. It will protect the photodegradation on riboflavin and furthermore reduce the off-flavours in the milk. The gojiberry-flavoured aaruul can be assumed to be a good source of bioactive compounds and it will possess important bioactivities such as immunomodulation, antitumor, neuroprotection and antifatigue. The gojiberry-flavoured aaruul will also contain more antioxidants, minerals and vitamins compared the plain aaruul samples in this study.

## 5.3 Cultural aspects

Nomadic herding and the making of traditional dairy products, such as aaruul, are at the core of the Mongolian society and it provides national employment. The huge wealth of traditional milk products plays a central role in the Mongolian culture and the livelihoods of nomadic herders. It is important to support the herders and the rural economy to enhance livelihood security and sustainability in the rural areas. Exporting a traditional food product like aaruul would mean an improvement of the urban commerce and the rural economy in Mongolia. It would also support cultural activities and help preserve the unique Mongolian culture. Aaruul, as an export product, would therefore have cultural aspects as an added value. It would promote and support the heritage and culture of Mongolia and offer a cultural awareness of Mongolia to the consumers.

## 5.4 Aaruul – Potential Mongolian product for export

Mongolian aaruul is a food product that can offer quality and distinctive Mongolian advantage to the world. The raw materials are produced where pesticides and other chemicals are rarely or never used, which makes aaruul a “clean” food product. Also the short list of ingredients with no unnecessary or unhealthy additives, support the fact that it can be considered a pure food product. Based on the literature findings all different milk sources are an excellent basis to make a healthy aaruul. It is hard to draw a certain conclusion, which dairy source that could be the most suitable and health beneficial raw material for aaruul, based on the literature findings. This is due to the various quality and amount of research that has been performed on the different milk sources included in this study. However, the horse milk appears to contain less nutrients and less health promoting features compared to the other milk sources included in this study. The horse milk also demonstrated to be hard to convert in to curd and thus needs additives in order to be a suitable milk source for aaruul. These factors make the horse milk the least promising milk source for the product under study. Aaruul with the addition of sea buckthorn or gojiberries could be considered to be the most suitable aaruul from both a health and acceptability perspective. The berries add nutrients to the aaruul in form of minerals, vitamins and antioxidants etc. and the berries protect other nutrients in the product. Furthermore, the aaruul with the addition of gojiberry got the highest liking in the acceptance test and is therefore the most promising aaruul of the six samples included in the test. Mongolian aaruul does not only have health as an added value, but it would also have a cultural aspect added.

Although aaruul is an interesting product from a health aspect, the result indicates that it is not found to be highly palatable if it is produced and consumed according to Mongolian tradition. In order to reduce off-flavours and avoid deteriorating of nutritional values and formation of toxic products it is recommended to dry the product away from light. This will increase the nutritional value of the product and make it more palatable. In order to accurately determine the health aspects of aaruul it is recommended to have aaruul analyzed for its nutritional value and its health promoting properties. Additionally to investigate how to make aaruul more palatable, further studies, trials and sensory evaluations of aaruul are recommended. Investigating the product concept in order to showcase the aaruul qualities and features is another recommendation in order to find a market for the product.

# 6. Conclusion

The results presented showed that it is possible to produce aaruul out of milk from cow, yak, goat and camel. Horse milk demonstrated an inability to form a curd and thus excluded from the acceptance test. Although further studies are needed to confirm the potential consumer's acceptance of the product, the results from this study indicate that aaruul does not extensively appeal to non-Mongolians. Aaruul based on cow milk with the addition of gojiberries had the highest acceptance of the six samples, but still it only reached to between "*neither like or dislike*" to "*like it slightly*" on the hedonic scale.

Based on the literature findings, all different milk sources are an excellent basis to make a healthy aaruul. However, horse milk was found to be the least nutritious milk source of the five included in the study. The addition of the native Mongolian berries of sea buckthorn and goji showed, not only to make the aaruul more palatable, but also increased the nutritional value of the product.

Even though many nutrients are lost in the process of making aaruul, the product can still be considered to possess many health beneficial properties, such as being a good source of vitamins, minerals, healthy fatty acids and proteins. Aaruul could also be suggested as a food that could help protect the teeth from the demineralization process.

Mongolian aaruul is a food product that can offer quality and distinctive Mongolian advantage to the world. Mongolian aaruul does not only have health as an added value, but it also has a cultural aspect added to its features. However, in order to make aaruul more healthy and palatable a review of the process, further studies and sensory evaluations are recommended.

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Aaruul pieces (2x2 cm) drying in the sun.

**Tester number:**

# Acceptability Test – Aaruul (dried curdled milk)

Please fill out the questionnaire in the order the questions appear on the sheet and answer every question. You will be served six samples of aaruul. Please taste the samples according to the number on each page. Do not go back and re-taste the samples once you have turned the page.

Please take a sip of water before you taste each product. When tasting it is important to take a big bite in order to be able to form an opinion.

## Part 1. Background

| | |
|---|---|
| **1. When were you born?** | Year 19______ |
| **2. Gender** | ❑ Female<br>❑ Male |
| **3. Nationality** | ________________________________ |
| **4. Have you conducted a consumer test during the last three months?** | ❑ Yes<br>❑ No<br>If yes, please notify the server.<br>If no, please continue to question number 5. |
| **5. Do you eat yoghurt regularly?** | ❑ Yes<br>❑ No |
| **6. Do you eat cheese regularly?** | ❑ Yes<br>❑ No |
| **7. Have you tried aaruul before?** | ❑ Many times<br>❑ A few times<br>❑ Once before<br>❑ Never<br>❑ Other:______________ |

Please go to the next page.

## Part 2. Testing

**Please taste the samples in the order presented, from left to right. Make sure you answer the questions matching the correct sample number. Remember to take a sip of water before you taste each sample.**

---

Sample #____________________________

**8. How much did you like or dislike the aaruul? Check one phrase to indicate your overall opinion of the product.**

- ❑ Like it extremely
- ❑ Like it very much
- ❑ Like it moderately
- ❑ Like it slightly
- ❑ Neither like nor dislike it
- ❑ Dislike it slightly
- ❑ Dislike it moderately
- ❑ Dislike it very much
- ❑ Dislike it extremely

---

Please go to the next page.

**Make sure you answer the questions matching the correct sample number. Remember to take a sip of water before you taste each sample.**

Sample #________________________

**9. How much did you like or dislike the aaruul? Check one phrase to indicate your overall opinion of the product.**

- ❑ Like it extremely
- ❑ Like it very much
- ❑ Like it moderately
- ❑ Like it slightly
- ❑ Neither like nor dislike it
- ❑ Dislike it slightly
- ❑ Dislike it moderately
- ❑ Dislike it very much
- ❑ Dislike it extremely

Please go to the next page.

**Make sure you answer the questions matching the correct sample number. Remember to take a sip of water before you taste each sample.**

Sample #__________________________

**10. How much did you like or dislike the aaruul? Check one phrase to indicate your overall opinion of the product.**

- ❑ Like it extremely
- ❑ Like it very much
- ❑ Like it moderately
- ❑ Like it slightly
- ❑ Neither like nor dislike it
- ❑ Dislike it slightly
- ❑ Dislike it moderately
- ❑ Dislike it very much
- ❑ Dislike it extremely

Please go to the next page.

**Make sure you answer the questions matching the correct sample number. Remember to take a sip of water before you taste each sample.**

Sample #________________________

**11. How much did you like or dislike the aaruul? Check one phrase to indicate your overall opinion of the product.**

- ❑ Like it extremely
- ❑ Like it very much
- ❑ Like it moderately
- ❑ Like it slightly
- ❑ Neither like nor dislike it
- ❑ Dislike it slightly
- ❑ Dislike it moderately
- ❑ Dislike it very much
- ❑ Dislike it extremely

Please go to the next page.

**Make sure you answer the questions matching the correct sample number. Remember to take a sip of water before you taste each sample.**

Sample #________________________

**12. How much did you like or dislike the aaruul? Check one phrase to indicate your overall opinion of the product.**

- ❑ Like it extremely
- ❑ Like it very much
- ❑ Like it moderately
- ❑ Like it slightly
- ❑ Neither like nor dislike it
- ❑ Dislike it slightly
- ❑ Dislike it moderately
- ❑ Dislike it very much
- ❑ Dislike it extremely

Please go to the next page.

---

**Make sure you answer the questions matching the correct sample number. Remember to take a sip of water before you taste each sample.**

---

Sample #________________________

**13. How much did you like or dislike the aaruul? Check one phrase to indicate your overall opinion of the product.**

- ❑ Like it extremely
- ❑ Like it very much
- ❑ Like it moderately
- ❑ Like it slightly
- ❑ Neither like nor dislike it
- ❑ Dislike it slightly
- ❑ Dislike it moderately
- ❑ Dislike it very much
- ❑ Dislike it extremely

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**Thank you for participating!**

Appendix C - summary of the mineral and vitamin content for the various milk sources

Mean mineral composition (mg/kg milk) of the various milk sources included in the study.

| **Element (mg/kg)** | **Yak milk*** | **Horse milk**** | **Goat milk***** | **Cow milk****** | **Camel milk******* |
|---|---|---|---|---|---|
| **Calcium (Ca)** | 1545 | 823 | 1340 | 1140 | 1060 |
| **Potassium (K)** | 1372 | 517 | 1810 | 1600 | 1560 |
| **Magnesium (Mg)** | 154 | 66 | 160 | 120 | 120 |
| **Sodium (Na)** | 341 | 167 | 410 | 400 | 690 |
| **Phosphorous (P)** | 922 | 499 | 1210 | 900 | 630 |
| **Sulphur (S)** | 399 | --- | 280 | ---- | ---- |
| **Zinc (Zn)** | 7.31 | 1.99 | 5.6 | 4.4 | 4.4 |
| **Iron (Fe)** | 0.57 | 1.21 | 0.7 | 0.4 | 2.6 |
| **Manganese (Mn)** | 0.06 | 0.054 | 0.32 | 0.1 | 0.2 |
| **Copper (Cu)** | 1.07 | 0.23 | 0.5 | 0.1 | 1.6 |

* Li *et al*., (2011a), Sun *et al*., (2012)
** Csapó-Kiss *et al*., (1995)
*** Park *et al*., (2007)
**** Lindmark-Månsson *et al*., (2003)
***** Sawaya *et al*., (1984)

Mean vitamin composition (mg/kg milk) of the various milk sources included in the study.

| **Vitamin (mg/kg)** | **Yak milk** | **Horse milk**** | **Goat milk***** | **Cow milk****** | **Camel milk******* |
|---|---|---|---|---|---|
| **A** | ---- | 0.34 | 0.5 | 0.3 | 0.15 |
| **D** | ----- | 0.0032 | 0.0006 | 0.0003 | 0.016 |
| **E** | ---- | 1.128 | --- | 1.01 | 0.54 |
| **K** | ---- | 0.029 | --- | 0.0041 | --- |
| **C** | ---- | 17.2 | 12.9 | 11.6 | 23.7 |
| **Thiamine ($B_1$)** | ---- | 0.16 | 0.68 | 0.4 | 0.330 |
| **Riboflavin ($B_2$)** | ---- | $3.9x10^{-7}$ | 2.1 | 1.41 | 0.416 |
| **Niacin ($B_3$)** | ---- | 0.5 | 2.7 | 0.64 | 4.61 |
| **Pantothenic acid ($B_5$)** | ---- | 3.2 | 3.1 | 3.4 | 0.88 |
| **Vitamin $B_6$** | ---- | ---- | 0.46 | 0.42 | 0.523 |
| **Folic acid ($B_9$)** | ---- | ---- | 0.01 | 0.056 | 0.0041 |
| **Biotin** | ---- | ---- | 0.015 | 0.011 | ---- |
| **Vitamin $B_{12}$** | ---- | ---- | 0.00065 | 0.0041 | 0.0015 |

** Csapó *et al*., (1995), Pearson, (1947)
*** Park *et al*., (2007)
**** Lindmark-Månsson *et al*., (2003)
***** Sawaya *et al*., (1984), Farah *et al*., (1992), Zhang *et al*., (2005)

Elisabeth Daginder

## Aaruul – sundried yoghurt – a potential Mongolian export product

Mongolia, landlocked between Russia and Asia, is probably most known for its vast steppes and their father of the nation and famous conqueror Chinggis Khaan. The country is less recognized internationally for its cuisine. However, Mongolia has many exciting traditional food products, which are predominantly based on meat and dairy products, to offer the world. One of these products is aaruul, a sundried yoghurt.

Mongolian companies in general compete on price rather than quality or a unique advantage. A flood of cheap, good-quality imports into Mongolia will destroy many domestic businesses and agricultural producers. The inevitable rise in the Mongolian currency will go further and it will destroy all industries competing on price alone. Mongolia could compete internationally by selling products with extra value that has been added in Mongolia. A unique value, which international consumers know about and appreciate, will bring profit and commercial power back to Mongolia. The solution for Mongolian companies is therefore to develop brands offering quality and distinctive Mongolian advantage to the world. Aaruul may be a food product that fits that description.

The possibility to produce aaruul, according to Mongolian tradition, of milk from yak, horse, goat, cow and camel was investigated. The result showed that horse milk did not form a curd, due to a presumed low dry matter in the raw material. Six different samples of aaruul were produced successfully based on milk from yak, goat, cow, camel, cow with addition of dried sea buckthorn berries and cow with addition of dried gojiberries. The six aaruul samples were included in a taste test (acceptance test) were 76 potential consumers from 26 different countries (Mongolia excluded) participated. The result showed a low level of acceptance for all products. Aaruul based on cow milk with the addition of gojiberries had a significantly higher liking compared to the other samples with a mean of 5.4 on a 9-point hedonic scale where 1 stand for “dislike it extremely” and 9 stands for “like it extremely”. The results indicated that aaruul, produced and consumed according to Mongolian tradition, has a low level of liking amongst the international consumers included in the study. However, the study showed that the addition of berries results in a higher liking among the potential consumers.

The aaruul’s health and cultural value was also investigated. Aaruul possess various health promoting properties depending on the raw material used to produce the product. The different types of milk contribute with various nutrients to the product, but they all have relatively similar health promoting properties. However, the literature study indicated that milk from horse had the lowest mineral and vitamin content and appeared to contain less health-promoting features compared to the other milk sources included in this study.

Some nutrients are lost during the process of making aaruul, due to the heating and drying of the product. The drying of aaruul in the sun might also add off-flavours and form toxic products in the product. Even though many nutrients are lost in the process, the product can still be considered to possess many health beneficial properties, such as being a good source of vitamins, minerals, healthy fatty acids and proteins. Aaruul could also be suggested as a food that could help protect the teeth from the demineralization process. The addition of sea buckthorn or gojiberries further contributes to an increased nutritional value of the product.

An increased production of aaruul in Mongolia due to a higher demand for the product internationally would contribute to an improvement of the urban commerce and the rural economy in Mongolia. It would also support cultural activities and help preserve the unique Mongolian culture. Aaruul, as an export product, would therefore have cultural aspects as an added value. It would promote and support the heritage and culture of Mongolia and offer a cultural awareness of Mongolia to the consumers.

This pilot studie show that it is possible to produce aaruul out of milk from cow, yak, goat and camel without any additives. A taste test among 76 potential consumers indicated that the product is poorly appreciated, but the addition of berries improves the taste of the product. The sun drying process has showed to produce off-flavour, toxic products and lower the nutritional value of the product and further studies are therefore recommended to investigate different methods to increase the nutritional value of the product and to make it more palatable. Aaruul has the potential to offer the consumers a product with many health-promoting properties and to support the unique culture and rural economy in Mongolia.

# Aaruul – soltorkad yoghurt – en potentiell Mongolisk exportprodukt

Mongoliet, som ligger inklämt mellan Ryssland och Kina, är förmodligen mest känd för sina vidsträckta stäpper och sin landsfader Chinggis Khan och mindre känd för sin kulinariska förmåga. Dock har landet många spännande traditionella livsmedelsprodukter, baserade huvudsakligen på mjölk och kött, att erbjuda världen. En av dessa produkter är aaruul, en soltorkad yoghurt.

Mongoliska företag konkurrera i allmänhet med pris snarare än kvalitet eller ett unik mervärde. En ström av billiga, kvalitets varor importeras till Mongoliet och kommer att förstöra många inhemska företag och jordbruksproducenter. Den oundvikliga ökningen av den mongoliska valutan kommer att fortsätta och det kommer att förstöra alla företag som konkurrerar enbart på pris. Mongoliet kan konkurrera internationellt genom att sälja produkter med Mongoliskt mervärde. Ett unikt värde som kommer att ge vinst och kommersiell makt tillbaka till Mongoliet. Lösningen för mongoliska företag är därför att utveckla varumärken, som erbjuder kvalitet och utmärkande mongoliskt värde internationellt. Aaruul kan vara ett livsmedel, som passar in på den beskrivningen.

Möjligheten att tillverka aaruul enligt mongolisk tradition av mjölk från jak, häst, get, ko och kamel undersöktes. Resultatet visade att hästmjölk inte bildade en yoghurtmassa på grund av en förmodad för låg torrsubstans. Sex olika aaruul framställdes resultatrikt baserad på mjölk från jak, get, ko, kamel, samt komjölk smaksatt med havtorn och komjölk smaksatt med gojibär. Dessa sex produkter ingick sedan i ett smak test (s.k. acceptanstest) på 76 potentiella konsumenter från 26 olika länder (Mongoliet exkluderat). Dock visade resultatet en låg acceptans för alla produkter. Komjölks aaruul smaksatt med gojibär utmärkte sig från mängden med den högsta acceptansnivån på 5.4 på en 9 gradig s.k. hedonisk skala, där 1 står för ”tycker extremt illa om” och 9 står för ”tycker extremt mycket om”. Resultaten indikerade att aaruul, tillverkad och konsumerad enligt Mongolisk tradition, har en lågt gillande bland internationella konsumenter. Dock visade studien att smaksättning med bär ger ett högre gillande bland de potentiella konsumenterna inkluderade i studien.

Utöver aaruul sorternas acceptans bland konsumenterna undersöktes även produktens hälso- samt kulturella mervärde. Beroende på vilken råvara aaruul baseras på får produkten olika hälsofördelar för konsumenten. De olika mjölksorterna bidrar med olika näringsämnen, men kan alla anses besitta relativt liknande hälsobringande egenskaper. Litteraturstudien indikerade dock att hästmjölk hade lägst mineral och vitamin innehåll och saknade vissa andra intressanta hälsoegenskaper. Dock förloras en del näringsämnen under processen då råvaran värms upp samt torkas. Trots förlorade näringsämnen, så uppvisar aaruul många hälsosamma kvaliteter såsom en hög halt av kalcium, en förmåga att skydda tänderna från karies samt en viktig källa för många vitaminer, mineraler, hälsosamma fettsyror samt proteiner. Tillsatsen av havtorn eller gojibär bidrar ytterligare till ett ökat näringsvärde hos produkten.

En ökad produktion av aaruul i Mongoliet på grund av förhöjd efterfrågan av produkten internationellt skulle innebära en ökad försörjningsmöjlighet för de nomadiserade boskapsskötarna, vilket även skulle ge ett välbehövligt stöd för landsbygdsekonomin samt bidra till att bevara den unika mongoliska kulturen. Aaruul som exportprodukt skulle därför även ha kulturella aspekter som mervärde. Aaruul främjar och stöder arvet och kulturen i Mongoliet och erbjuder en kulturell medvetenhet beträffande Mongoliet för konsumenterna.

Denna förstudie visar att det är möjligt att producera aaruul av ren mjölk från jak, get, ko och kamel utan några tillsatsämnen. Ett smaktest bland 76 potentiella konsumenter indikerade att produkten är föga uppskattad, men att smaksättning med bär lyfter smaken på produkten. Soltorkningssteget i processen har visat sig producera bismaker samt vissa skadliga ämnen och därför rekommenderas ytterligare studier för att undersöka olika metoder för att göra produkten mer välsmakande. Aaruul har potential att erbjuda konsumenten en produkt med många hälsobringande aspekter samt främja den unika kulturen och landsbygdsekonomin i Mongoliet.