Journal of Applied Agricultural Science and Technology **E-ISSN: 2621-2528**
JAAST 8(2): 267-281 (2024) ***ISSN: 2621-4709***

PHYSICOCHEMICAL PROPERTIES OF PASTEURIZED COW'S MILK: REVIEW

Annisa' Suci Rahmadini[1], Alfi Asben[1], Kurnia Harlina Dewi[1], Yuni Ernita[*,2]

[1]Department of Agricultural Industry Technology, Universitas Andalas, Padang, Indonesia
[2]Study Program of Agricultural Mechanization Technology, Politeknik Pertanian Negeri Payakumbuh, Lima Puluh Kota, Indonesia

*Corresponding author
Email: yuniernita00@gmail.com

Abstract. *The purpose of pasteurization of milk is to improve the quality of the milk, kill pathogenic and non-pathogenic bacteria. The heating process is carried out to eliminate pathogenic microorganisms in milk, but pathogenic microorganisms can grow again after processing and packaging milk. Based on this, it is necessary to test the safety level of pasteurized milk. An important test that needs to be carried out is the physicochemical properties. The results of testing pasteurized milk using a cold chain showed a pH of 6.7, protein content about 2.67%, and fat content about 3.37%. The influence of pasteurized milk storage conditions on its physicochemical properties also needs to be tested. The test results showed that the acidity of pasteurized milk increased during two days of storage at 20°C from 0.142 ± 0.00119% to 0.162 ± 0.00342%, the pH was lowered by 0.068 units, the average electrical conductivity (EC) increased from 5.220±0.0397 mS/cm to 5.880±0.1006 mS/cm. Increasing temperature and storage time causes an increase in phosphate ions and lowers pH rapidly, because acidification of milk causes changes in salt balance. Physical and sensory quality tests of pasteurized milk products were also carried out to determine the effect of temperature and transportation time. The test results explained that at 72 hours of transportation with a temperature of 5°C, the pH value was 6.7-6.8. These results indicate that the pH of pasteurized milk still complies with SNI, this condition is also supported by the sensory condition which is still normal.*

Keywords: *physicochemical properties; pasteurized milk; cow's milk*

1. Introduction

Milk is a very important source of animal protein for humans because it contains essential amino acids which play a role in health status and increase people's intelligence (Brilianty *et al*., 2022). Milk contains a balanced combination of protein, fat, lactose, minerals, and vitamins, providing the macro and micronutrients that are necessary for human health (Liu & Rochfort, 2023). According to Suhaillah and Santoso (2018), milk is the result of the secretion of the mammary glands of female mammals as a source of nutrition for their children. Fresh cow's milk is a liquid obtained by milking dairy cows, without adding or subtracting natural ingredients, and without any processing or preparation. (Yudonegoro *et al*., 2014).

According to the Biro Pusat Statistik (BPS) in 2021 the annual domestic production of fresh milk is about 997.35 thousand tons/year. This sum is as it were adequate for 22 percent of the total demand, which is 3.8 million tons/year. The Milk Processing Industry has a big opportunity to provide milk products for 220 million people of Indonesia, whose average consumption in 2020 only reached about 16.27 kg per capita/year, still lower than neighboring countries, such as

Received January 6, 2024; Accepted March 15, 2024; Published May 30, 2024
https://doi.org/10.55043/jaast.v8i2.272

This is an open access article under the CC BY-SA 4.0 license https://creativecommons.org/licenses/by-sa/4.0

Vietnam, which reached 20 kg/capita/year or Malaysia around 50 kg/capita/year (Cahyaningrum, 2023).

A natural food item high in nutrients that are vital to the growth and development of the human body is milk. The nutritional value of cow's milk on average has a water content of 84 – 90%, solid material of 10 – 16%, fat of 2.60 – 6.00%, protein of 2.80 – 4.00%, lactose of 4.50 – 5 .20%, and minerals as much as 0.60 – 0.80% (Muchtadi, 2019). The type of cow, amount of lactation, nutrition, time between milkings, and age all affect the content of the milk produced by cows. (Hendrawati, 2017). Furthermore, according to Zhao *et al*. (2023), fresh milk's flavor and nutritional value are strongly impacted by the metabolic state of dairy cows. The growth of pathogenic bacteria, transfer of chemicals, and transmission of other pollutants can occur in highly nutritious milk, causing the milk to be easily contaminated and easily damaged (Nirwal *et al*., 2013). The primary barrier to dairy product shelf life extension is the challenge of getting rid of or eradicating spoiling microbes (Antunes *et al*., 2014). Raw milk contains a variety of pathogens, gram-positive and negative bacteria, rotting bacteria, and organisms that cause disease in animals (Martin *et al*., 2018). The raw milk is contaminated with bacteria when it comes out of the animal's udder; however, it can also be contaminated by bacteria from the cow's environment or from contact with contaminated equipment (Martin *et al*., 2023). To meet consumer demand for milk, pasteurization is necessary as an alternative method that can produce safe and high-quality milk sustainably (Alsaedi *et al*., 2023).

Pasteurization is a method of preserving milk by heating it to precisely the right temperature, which kills harmful germs and increases the milk's shelf life. In order to guarantee safety and prolong shelf life, conventional milk pasteurization processes rely on batch heat treatment followed by cooling (Lott *et al*., 2023b). Ambarsari *et al*. (2013), stated that pasteurization is heat treatment below 100^{o}C to kill most pathogenic microorganisms while maintaining the nutritional content, physical properties and taste of fresh milk.

As per SNI 01-3951-1995, pasteurized milk is defined as milk that has been heated to a minimum temperature of 72^{o}C for 15 seconds or at a temperature between 63-66^{o}C for 30 minutes, it is then promptly cooled to 10^{o}C, processed aseptically, and stored at a maximum temperature of 4.4^{o} C (BSN, 1995). Enhancing the quality of milk and eliminating both harmful and non-pathogenic microorganisms are the goals of milk pasteurization (Wanniatie & Hanum, 2015). According to Ritota *et al*. (2017), Arini (2017), Myer (2016), milk pasteurization is carried out so that the milk is safe for consumption and has a long shelf life. According Cole *et al*. (2022), the purpose of pasteurizing milk is to reduce the amount of practically degradable microorganisms and to prolong the shelf life by pulverizing compounds that are unpleasant and displaying pathogens inside the milk. The pasteurization process will kill pathogenic bacteria such as Salmonella, Listeria, Campylobacter, and pathogenic Escherichia coli in milk (Marangoni *et al*., 2014). The pasteurization target is to achieve a reduction of live microorganisms of 99.999% (5 log) (Cole *et al*., 2022).

Three methods of pasteurization of milk are commonly carried out by (Ritota *et al*., 2017), namely: 1. Low Temperature Long Time (LTLT) Pasteurization, specifically a pasteurization process that uses low temperatures for a long time (minimum 63°C for 30 minutes). 2. High Temperature Short Time (HTST) pasteurization, namely a pasteurization process that uses high temperatures for a short time (minimum 72°C for 15 seconds). 3. Ultra High Temperature (UHT) Pasteurization, namely a pasteurization process that involves a continuous flow of heat at a high temperature and a relatively short period of time (more than 0.5 seconds at a temperature of 135°C). The sterilization method used can affect the nutritional content and taste of food products. The HTST method carried out on milk is considered more effective than the LTLT method. The HTST method preserves vitamins and enhances sensory aspects of dairy products. It is the method of choice in dairy factories when compared to other pasteurization procedures. (Indumathy *et al*., 2022), however the HTST method cannot completely inactivate bacteria in milk, thus having a serious impact on quality, safety, and product shelf life (Yang *et al*., 2023).

According to Gelagar *et al*. (2017), temperature and time during pasteurization are important factors that need to be considered in determining milk quality and shelf life conditions. Meanwhile, according to Maryana *et al*. (2016), the temperature during the pasteurization process cannot be effectively regulated, so the resulting milk is vulnerable to bacterial infection. For this reason, it is essential to give natural substances that can enhance the quality of pasteurized milk. Furthermore, Wanniatie and Hanum (2015), found that although pasteurized milk undergoes a heating process and is free from pathogenic microorganisms, pasteurized milk can be contaminated with microorganisms after processing and packaging. Post-pasteurization contamination of milk liquid is usually caused by gram-negative bacteria (Lott *et al*., 2023a). Contaminated milk contains bacteria such as Staphylococcus aureus, Salmonella spp., Listeria monocytogenes, Bacillus cereus, and Campylobacter spp. that can lead to food-borne diseases (Anderson *et al*., 2011).

High temperatures can degrade pasteurized milk by causing harm to the organoleptic system, depletion of nutrients, and the creation of hazardous compounds (Ding *et al*., 2020). According to Hutagaol (2013), to maintain the quality of pasteurized milk which still contains Staphylococcus aureus is to store it at a low temperature. The storage stability of pasteurized milk is very important for producers because it relates to microbiological, biochemical, and sensory issues (Incecco *et al*., 2024). Based on this, it is necessary to test the safety level of pasteurized milk produced by the milk processing industry by comparing it to the Indonesian National Standard (SNI). One way to test the safety of pasteurized milk is by testing its physicochemical properties. The research objectives are: to determine the effect of handling, processing, storage temperature and time, as well as transportation temperature and time on the physicochemical properties of pasteurized milk.

2. Physicochemical Properties of Milk

The majority of milk's behavior and interaction energy are measured by its physical qualities, while the majority of milk's physico-chemical properties are determined by the particles, molecules, atoms, and colloid ions that make up the milk (McCarthy, 2022). From a chemical standpoint, milk is a complicated liquid made up of over 100 different components (Chandan, 2002). Based on a psychological perspective, milk is a fluid produced from the glands of female mammals which is used for initial nutrition for their young. From a physicochemical perspective, milk is categorized as a white liquid in terms of multi dispersion.

2.1. Physical Properties of Milk

The physical characteristics of milk that are most significant include its specific gravity, viscosity, freezing point, color, taste, and scent. The type of dairy cow, the diet, the feeding schedule, the frequency and technique of milking, the changing seasons, and the length of lactation all affect the physical and chemical quality of fresh cow's milk (Lingathurai *et al*., 2009).

2.1.1. Color, Smell, and Taste of Milk

The color, aroma and taste of milk according to SNI (2011) are: yellowish white, a typical aroma of the type of livestock itself, savory taste and slightly fatty. The yellowish white color comes from casein. According to Buckle *et al.* (2007), casein in milk is white like snow, and opaque because it is a colloidal dispersion. The distinctive smell of milk according to the livestock itself is caused by several compounds which have a specific aroma and some of which are volatile. The taste of milk, apart from being savory and slightly fatty, is also slightly sweet, because milk contains around 4.8% milk sugar in the form of lactose. Subnormal tastes easily develop in milk and this may be the result of physiological, enzyme, chemical and mechanical causes. According to Navyanti and Adriyani (2015) color, taste and smell will not be affected if there is no contamination by foreign objects such as antibiotics or drug residues in the milk.

2.1.2. Milk Specific Gravity

The minimum value for the specific gravity of milk is according to SNI-3141.1-2011, Which is about 1.0270 g/mL at a temperature of 27.5°C. Milk has a greater specific gravity than water. However, according to the milk codex, the BJ of milk is 1,028. The milk codex is a list of units that must be fulfilled by milk as a food ingredient. This list has been agreed upon by nutrition and health experts worldwide, although each country or region has its own provisions.

2.1.3. Viscosity (thickness)

Milk viscosity usually ranges from 1.5 – 2.0 cP. Solid ingredients, fat, and temperature affect milk viscosity. Buckle *et al*. (1987) stated that the most typical characteristic of milk is coagulation. Addition of acid or enzyme activity can cause milk to curdle. Proteolytic enzymes made by bacteria can also cause clumping. Calcium ions in milk are very important for the settling process. If deviations occur, the milk can turn liquid or even become too thick, this is due to milking factors and livestock factors (Diastari & Agustina, 2013).

2.1.4. Freezing Point and Boiling Point of Milk

Milk has a freezing point of -0.50ºC, whereas water has a freezing point of 0ºC. For Indonesia, it is now -0.52ºC. Determining the freezing point of milk is critical to assessing the quality of dairy cow's milk since it fluctuates in response to changes in the milk's water content. The chemical composition of milk, specifically the amounts of lactose and minerals, can be used to determine how high or low the freezing point of milk will rise or fall. The freezing point of milk will increase with decreasing quantities of lactose (Murti, 2016). There is a strong correlation between the specific gravity and boiling point of fresh milk. There exists a positive correlation between the boiling point and weight of milk. Compared to water, milk has a higher boiling point. The boiling points of fresh milk and pure water are 100.16 and 100.17 degrees Celsius, respectively, at sea level. The greater the quantities of minerals and lactose in milk, the greater its freezing point (Melia *et al*., 2018). If there is milk adulteration by adding water, it can easily be tested using a freezing point determination test. Milk added with water will show a freezing point that is greater than water and smaller than milk.

2.2. Chemical Properties of Milk

2.2.1. Acidity and pH of milk

Fresh milk has amphoteric properties, meaning it can be both acidic and basic. The hydrogen ion potential (pH) of fresh milk is between 6.5 – 6.7. If the pH value of breast milk is higher than 6.7, it usually means mastitis and if the pH is below 6.5, it indicates the presence of colostrum or bacterial deterioration (Saleh, 2004). The bacteria that cause increased milk acidity can come from cows suffering from mastitis, as well as milk contaminated with bacteria after milking or normal bacteria that are able to ferment lactose into lactic acid. The acidity level of milk can decrease, which means its quality also decreases due to bacterial activity in utilizing lactose to become lactic acid (Khoirani, 2015). For this reason, milk can be treated to maintain its quality, such as by cooling, pasteurization, or a combination of heating and cooling which aims to inhibit the growth or kill the bacteria.

2.2.2. Fat level

The largest contents of milk are water and fat. Fat is found in milk in the form of millions of small balls with a diameter of between 1 – 20 microns with an average diameter of 3 microns (Buckle *et al*., 2007). Usually, there are around 1000 x 106 fat globules in every ml of milk. These granules make milk easily absorb foreign flavors. The percentage of milk fat varies between 2.4% - 5.5%. Cow's milk contains 63% saturated fatty acids (ALJ), 30% monounsaturated fatty acids (ALTJT), and 7% polyunsaturated fatty acids (ALTJG) (Mourad *et al*., 2014).

Milk fat contains many nutrients that are beneficial for humans, such as fat-soluble vitamins (A, D, E, and K), and essential fatty acids (Le *et al*., 2015). Milk fat content can be influenced by genetics, feed, rearing methods, climate, lactation period and animal health (Fitriyanto *et al*., 2013). The type of feed that is very influential in increasing milk fat content is forage because milk fat content depends on the crude fiber content in the feed (Riski *et al*., 2016). The growth of microorganisms can also affect milk fat. The large number of microorganisms will cause milk to clot which is caused by damage to the fat structure resulting in a decrease in milk quality (Wanniatie & Hanum, 2015).

2.2.3. Protein content

According to Winarno (1993), milk is a source of very high quality protein. Cow's milk protein content is around 3.5%. Milk protein consists of three main types of protein, there are casein, lactalbumin, and lactoglobulin. These three types of protein are present in colloidal form, do not form layers, and are uniformly dispersed in milk. In contrast to fat, protein can only provide energy of ± 4.1 calories per gram (Mukhtar, 2006). Casein is the main protein in milk, accounting for 80% of the total protein in cow's milk. Casein can be precipitated by acid and the enzyme renin. Homogenization which is usually carried out in milk processing causes some of the casein particles to combine with fat globules.

3. Testing of the Physicochemical Properties of Pasteurized Milk

The quality requirements for pasteurized milk according to SNI are used as a guideline for determining the quality of milk to be sold to consumers by the milk processing industry. The Indonesian standard for pasteurized milk is SNI 01-3951-1995 (Table 1).

According to Al-Farsi *et al*. (2021), milk quality is a major concern in various countries. A multitude of factors can impact the microbiological quality of pasteurized milk, including the duration and temperature of the pasteurization process, the type of packaging material used, the temperature during transportation, and the storage practices used for both retail and consumer pasteurized milk (Angelidis *et al*., 2016). Wanniatie and Hanum (2015) tested the quality of pasteurized milk from shops, supermarkets and retail agents in the DKI Jakarta and Bogor areas.

Testing was carried out using the Gerber method, Formol and the Fleischmann formula (Sudarwanto, 2012). The milk fat content test results ranged from 3 – 4%, by SNI (1995). The milk protein content tested ranged from 2.9 to 3.4%. This is still in accordance with SNI (1995), the minimum is 2.5%. The dry matter content of pasteurized milk ranges from 10.7 to 12.6%. The nonfat dry matter (BKTL) content of pasteurized milk tested ranged from 7.3 to 8.9%. In SNI (1995) the minimum limit for BKTL is 7.7%. This shows that there are samples that do not comply with the specified requirements. The low level of BKTL in pasteurized milk is probably because the milk constituents (except fat) were low from the start.

Table 1. Pasteurized Milk SNI 01-3951-1995

Characteristics	Condition		Testing method
	A	B	
Smell	Typical	Typical	Organoleptic
Flavor	Typical	Typical	Organoleptic
Color	Typical	Typical	Organoleptic
Fat content % (wt/weight) min	2.80	1.50	SP-SMP-248-1980
Non-fat solids content % (w/w) min	7.7	7.5	SP-SMP-249-1980
Reductase assay with methylene blue	0	0	
Protein content % (wt/weight) min	2.5	2.5	SP-SMP-79-1975
Phosphatase test	0	0	
T.P.C (Total Plate Count), ml, max	3 x 10^4	3 x 10^4	
Coliform presumptive MPH/ml, max	10	10	
Dangerous metal			
1. 1.As, (ppm) max,	1	1	
2. 2.Pb, (ppm) max,	1	1	
3. 3.Cu, (ppm) max,	2	2	
4. 4.Zn, (ppm) max,	5	5	
Preservatives			In accordance with the Republic of Indonesia Minister of Health Regulation No. 235/Men. Case/Per/IV/79

Note: A = Pasteurized milk without flavoring B = Pasteurized milk with flavoring

Wulandari *et al*. (2017), research was conducted on pasteurized milk using a cold chain. The pH test was carried out according to SNI 01-2782-1998 (BSN, 1998) and it was found to be 6.7. Protein Content Test using the Formol Titration Method (AOAC, 2005; Milkotester, 2017) was found to be 2.67%. Fat content test using the Gerber method according to SNI 01-2782-1998 (BSN, 1998; Milkotester, 2017) was found to be 3.37%. The test's findings clarify that while certain pathogenic microbes remain in milk after pasteurization, which affects the pH of pasteurized milk, the activity of temperature-resistant microorganisms is what causes the pH value of pasteurized milk to rise. Protein content complies with SNI guidelines, with a minimum of 2.5%. Because pasteurization involves heating, the protein level of pasteurized milk is lower than that of fresh milk. The minimal fat percentage for pasteurized milk is 2.8% for unflavored milk and 1.5% for flavored milk, as per the standards set by the SNI. The basic ingredients and precision of the processing method determine the fat level of pasteurized milk (Susilorini & Sawitri, 2006). The fat content value decreased significantly after the processing process.

Maharani *et al*. (2020) tested the quality of milk from milk shops in the Bogor Pier IPB area. Milk composition was checked using a lactoscan (Milkotronic Lactoscan SLP) connected to a thermal receipt printer (Rongta RP58E-S). The average test results were: specific gravity is 1.019, fat content is 2.66, protein content is 2.02, and pH is 6.89. The test results show that the specific gravity value is under the minimum value of SNI-3141.1-2011. The low specific gravity value indicates that the density of the milk is also low. The addition of water, the amount of milk fat, the amount of feed dry matter (BK) and nonfat dry matter (BKTL) can all affect the specific gravity value. Changes in specific gravity in milk occur if the fat granules (globules), lactose, protein and salt in the milk change. The specific gravity of milk that has been mixed with water will decrease (Miller *et al*., 2007). A low specific gravity value indicates that the density of milk is also low (Maharani *et al*., 2020). The specific gravity number will rise with the amount of fat-free dry matter. The release of CO_2 and N_2 from the milk causes an increase in its specific gravity (Warni, 2014). The specific gravity value will decrease with an increase in fat content (Nurmayanti, 2016). Milk with a greater specific gravity value has superior quality since it has a lower water content and a concentrated nutritious content (Wulandari *et al*., 2017).

Caprita *et al*. (2014) investigated the effect of storage conditions on the physicochemical characteristics of several types of pasteurized cow's milk (Table 2). For forty-eight hours, pasteurized milk was stored at 4°C, 10°C, and 20°C. During two days of storage at 20°C, the acidity of pasteurized milk increased from 0.142 ±0.00119% to 0.162 ±0.00342%, and the pH decreased by 0.068 units. As a result of decreasing pH, calcium and phosphorus bonds are released from the structure of colloidal milk proteins and this creates electrical conductivity (EC) increases. The average EC in pasteurized milk increased from 5.220±0.0397 mS/cm to 5.880±0.1006 mS/cm after two days of storage at 20°C. The decrease in pH at 4°C was slower than at 10°C and 20°C. As the temperature and storage time increase, the pH decreases rapidly due to an increase in phosphate ions and acidification of the milk, which changes the salt balance (Muchetti *et al*., 1994). The shelf life of commercially available pasteurized milk is limited by the following bacteria that can survive the thermal process, namely Bacteria from the genera Pseudomonas and Bacillus, which represent the majority of bacterial contaminants after pasteurization and continue to multiply during milk storage due to their psychrophilic nature (Martin *et al*., 2018).

Rashid *et al.* (2019) found that temperature and duration had a significant impact on the physicochemical characteristics of pasteurized milk. pH, lipid, protein, and lactose contents all reduced during post-pasteurization cold storage, but levels of free fatty acid (FFA) and acidity increased dramatically at 10°C as opposed to 7°C and 4°C on day 19. Even on the ineteenth day of milk storage, there was very little color change of the nanoparticles due to interaction with volatiles at 4°C. Meanwhile, at a temperature of 10°C, there was a real change on the 14th to the 19th day of storage, indicating that the milk would be damaged according to the sensory score. This is in accordance with research by Limbo *et al.* (2020), where chemical and sensory quality showed good stability in pasteurized milk stored in the dark for up to 13 days. According to Hellwig (2019), pasteurized milk should be properly stored at 4ºC because raising the temperature will shorten its shelf life. This is because exposure to light on milk can trigger reactions that result in some undesirable flavors (Pawde *et al.*, 2023).

Tabel 2. Effect of storage temperature on some physicochemical of pasteurized milk

Time (h)	Temperature								
	4ºC			10ºC			20ºC		
	pH	%Lactic acid	electrical conductivity (m.s/cm)	pH	%Lactic acid	electrical conductivity (m.s/cm)	pH	%Lactic acid	electrical conductivity (m.s/cm)
0	6.880± 0.0192	0.142± 0.00119	5.220± 0.0397	6.880± 0.0192	0.142± 0.00119	5.220± 0.0397	6.880± 0.0192	0.142± 0.00119	5.220± 0.0397
24	6.872± 0.1570	0.148± 0.00249	5.260± 0.0197	6.852± 0.0141	0.150± 0.00240	5.300± 0.0237	6.848± 0.0163	0.152± 0.00166	5.420± 0.00951
48	6.878± 0.0156	0.152± 0.00194	5.284± 0.0258	6.834± 0.0100	0.155± 0.00196	5.364± 0.0290	6.812± 0.0194	0.162± 0.00342	5.880± 0.1006

Research by Rosadi (2017) stated that, the storage temperature significantly affected dissolved protein, however the interaction between various filling and storage temperatures only significantly affected the pasteurized milk's total microbiological value (Table 3). Apart from that, storage temperature also has a significant effect on pH, viscosity and fat of pasteurized milk in non-parametric data analysis using the Kruskal Wallis test and Mann's advanced test. Pasteurized milk filled at 70ºC and stored in the freezer was the best treated sample with a pH value of 6.52, viscosity 4 cP, soluble protein 0.86%, fat 3.5% and total microbes 2.62 log CFU/mL. Apart from that, the best treatment in the freezer was also due to consumer acceptance, where most consumers tended to preferred frozen pasteurized milk products.

The effect of temperature and transportation time on the physical and sensory quality of pasteurized milk products also needs to be tested. Apriliyani and Apriliyanti (2018), tested the physical and sensory quality of pasteurized milk products packaged in 250 ml bottles produced by SMEs in Malang City at different temperatures and transportation times. Determination of the pH value was carried out using a pH meter in accordance with AOAC (2005). The test results in Table

4 explain that at a transportation time of 72 hours with a temperature of 5°C, the pH value of 6.7-6.8 it shows that it corresponds to the normal pH of pasteurized milk, and this is supported by the normal sensory condition.

Table 3. Effect of filling and storage temperature on the physicochemical properties of pasteurized milk

Filling Temperature (T)	Storage	pH value	Viscosity (cP)	Soluble Protein (%)	Fat (%)	Total Microbes (log CFU/mL)
70^{0}C	No storage	6.53 ± 0.02	4 ± 1	0.87 ±0.02	3.6 ±0.1	2.45 ±0.08
	Refrigerator (day 5)	6.50 ± 0.01	5 ± 1	0.81 ±0.02	3.4 ±0.1	3.26 ±0.13
	Freezer (day 5)	6.52 ± 0.02	4 ± 1	0.86 ±0.03	3.5 ±0.0	2.62 ±0.33
60^{0}C	No storage	6.53 ± 0.02	4 ± 1	0.88 ±0.02	3.6 ±0.2	2.91 ±0.04
	Refrigerator (day 5)	6.51 ± 0.01	4 ± 1	0.83 ±0.06	3.4 ±0.1	4.07 ±0.06
	Freezer (day 5)	6.52 ± 0.01	4 ± 1	0.86 ±0.02	3.5 ±0.1	2.97 ±0.51
50^{0}C	No storage	6.53 ± 0.01	4 ± 1	0.90 ±0.02	3.5 ±0.1	3.72 ±0.03
	Refrigerator (day 5)	6.50 ± 0.02	4 ± 1	0.81 ±0.02	3.5 ±0.1	4.10 ±0.05
	Freezer (day 5)	6.53 ± 0.01	4 ± 0	0.87 ±0.02	3.5 ±0.1	3.77 ±0.05

Table 4. pH values and sensory distribution tests of pasteurized milk

Sample	Transportation time (hours)	Temperature (°C)	pH Value	Flavor	Smell	Texture	Bottle condition
P1	72	-15	6.0	Good	Special milk	Abnormal	Normal
P2	72	5	6.7	Good	Special milk	Normal	Normal
P3	72	15	5.3	Not good	Sour smell	Abnormal	Bulging
P4	108	-15	4.7	Not good	Sour smell	Normal	Bulging
P5	108	5	6.3	Good	Special milk	Normal	Normal
P6	108	15	5.0	Not good	Sour smell	Normal	Bulging
P7	129	-15	4.9	Not good	Sour smell	Abnormal	Bulging
P8	129	5	5.4	Good	Special milk	Normal	Normal
P9	129	15	4.6	Not good	Sour smell	Abnormal	Bulging

4. Conclusions

The process of pasteurization involves heating milk to precisely controlled temperatures in order to destroy harmful microorganisms and increase the milk's shelf life. Due to the heating process, pathogenic bacteria are eliminated from pasteurized milk; nonetheless, microbes may still infect pasteurized milk during processing and packing. In order to ascertain the degree of safety associated with the pasteurized milk produced, testing of its physicochemical qualities must be conducted. The results of testing the physicochemical properties of pasteurized milk show that pasteurized milk is greatly influenced by several factors, including: handling, processing, storage temperature and time, as well as transportation temperature and time. Based on this, to develop the milk processing industry in milk producing centers such as West Sumatra, it is necessary to test the physicochemical properties of the milk products produced in order to know whether the quality of the milk products is in accordance with the Indonesian National Standard.

References

Al-Farsi, M., Al-Gharibi, I., Al-Abri, A., Al-Humaimi, A., Al-Nabhani, F., Al-Hashmi, H., ..., & Al-Shibli, S. (2021). Evaluating the shelf-life of pasteurized milk in Oman. *J. Heliyon*, 7(3), 1-6. https://doi.org/10.1016/j.heliyon.2021.e06555

Alsaedi, A. W. M., Al-Mousawi, A. J., Al-Hilphy, A. R., & Gavahian. M. (2023). Non-thermal pasteurization of milk by an innovative energy-saving moderate electrical field equipped with elongated electrodes and process optimization. *Innovative Food Science & Emerging Technologies*, 88(103445). https://doi.org/10.1016/j.ifset.2023.103445

Ambarsari, I., Qanytah., & Sudaryono, T. (2013). Perubahan kualitas susu pasteurisasi dalam berbagai jenis kemasan. *Jurnal Penelitian dan Pengembangan Pertanian*, 32(1), 10-19. https://dx.doi.org/10.21082/jp3.v32n1.2013.p10-19 https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwiFgc__kuaDAxWW9zgGHZBjAJMQFnoECA4QAQ&url=https%3A%2F%2Fmedia.neliti.com%2Fmedia%2Fpublications%2F30914-ID-perubahan-kualitas-susu-pasteurisasi-dalam-berbagai-jenis-kemasan.pdf&usg=AOvVaw2jd3xIE7QnTm-y23HYyKPx&opi=89978449

Anderson, M., Hinds, P., Hurditt, S., Miller, P., McGrowder, D., & Lindo, R. A. (2011). The microbial content of unexpired pasteurized milk from selected supermarkets in a developing country. *Asian Pac. J. Trop. Biomed*., 1(3), 205-211. https://doi.org/10.1016/S2221-1691(11)60028-2.

Angelidis, A. S., Tsiota, S., Pexara, A., & Govaris, A. (2016). The microbiological quality of pasteurized milk sold by automatic vending machines. *Letters in Applied Microbiology*, 62(6), 472–479. https://doi.org/10.1111/lam.12572

Antunes, A. E. C., Alves, A. T. S., Gallina, D. A., Trento, F. K., Zacarchenco, P. B., & Van Dender, A. G. (2014). Development and shelf-life determination of pasteurized, microfiltered, lactose hydrolyzed skim milk. *J Dairy Sci*., 97(9), 5337-5344. https://doi.org/10.3168/jds.2014-8020

AOAC (Association of Official Analytical Chemist). (2005). *Official Method of Analysis of the Association of Official Analytical of Chemist*. Arlington (US): The Association of Official Analytical Chemist Inc. https://www.researchgate.net/publication/292783651_AOAC_2005

Apriliyani, M. W., & Apriliyanti, M. W. (2018). Kualitas Fisik dan Sensoris Produk Susu Pasteurisasi pada Suhu dan Waktu Transportasi dalam Distribusi Pemasaran. *Jurnal Ilmu dan Teknologi Hasil Ternak*, 13(1), 46-53. https://doi.org/10.21776/ub.jitek.2018.013.01.5

Arini, L. D. D. (2017). Pengaruh pasteurisasi terhadap jumlah koloni bakteri pada susu segar dan UHT sebagai upaya menjaga kesehatan. *Indonesian Journal on Medical Science*, 4(1), 119-132. https://ejournal.poltekkesbhaktimulia.ac.id/index.php/ijms/article/view/104

Badan Pusat Statistik Indonesia [BPS]. (2021). *Produksi Susu Segar menurut Provinsi (Ton), 2021-2022*. https://www.bps.go.id/id/statistics-table/2/NDkzIzI=/fresh-milk-production-by-province.html.

Badan Standardisasi Nasional [BSN]. (1995). *SNI 01-3951-1995. Susu Pasteurisasi*. https://dokumen.tips/documents/sni-01-3951-1995-susu-pasteurisasi.html?page=1

Badan Standardisasi Nasional [BSN]. (1998). *SNI 01-2782-1998. Metode Pengujian Susu segar*. https://pesta.bsn.go.id/produk/detail/3146-sni01-2782-1998

Badan Standardisasi Nasional [BSN]. (2011). SNI 3141.1:2011 tentang *Susu Segar Bagian-1: Sapi*. https://www.scribd.com/document/187753893/27705-SNI-3141-1-2011-Susu-Segar-Bag-1-Sapi

Brilianty, S. L., Suprihatin., S., & Purwoko, P. (2022). Penilaian Daur Hidup Produk Susu Sapi Segar: Studi Kasus di KPBS Pangalengan. *Jurnal Teknologi Industri Pertanian*, 32(3), 220-228, https://doi.org/10.24961/j.tek.ind.pert.2022.32.3.220

Buckle, K. A., Edwards, R. A., Fleet, G. H., & Wooton, A. (1987). *Ilmu Pangan. Terjemahan Hari Purnomo dan Adiyono*. Penerbit Universitas Indonesia. Jakarta. https://onesearch.id/Record/IOS4680.JATIM000000000016366

Buckle, K. A., Edwards, R. A., Fleet., G. H., & Wooton, M. (2007). *Ilmu Pangan*. Jakarta: Universitas Indonesia Press. https://lib.ui.ac.id/detail?id=20486194&lokasi=lokal

Cahyaningrum, S. Y. (2023). *Mengejar Kemandirian Industri Susu Nasional*. https://www.kompas.id/baca/nusantara/2023/06/01/mengejar-kemandirian-industri-susu nasional

Caprita, A., Caprita, R., & Cretescu, I. (2014). The Effects of Storage Conditions on Some Physicochemical Properties of Raw and Pasteurized Milk. *Journal of Agroalimentary Processes and Technologies*, 20(2), 198-202. http://journal-of-agroalimentary.ro/

Chandan, R. C. (2006). *Milk Composition, Physical, and Processing Characteristic Materials*. USA. Blackwell Publishing. https://doi.org/10.1002/9780470113554.ch64

Cole, S., Goetze, A., Meunier-Goddik, L. (2022). Pasteurized Milk. *Encyclopedia of Dairy Sciences (Third edition)*, 444-450. https://doi.org/10.1016/B978-0-12-818766-1.00142-2

Diastari, I, G, A, F., & Agustina, K, K. (2013). Uji Organoleptik dan Tingkat Keasaman Susu Sapi Kemasan yang Dijual di Pasar Tradisional Kota Denpasar. *Indonesia Medicus Veterinus*, 2(4), 453-460. https://erepo.unud.ac.id/id/eprint/100/1/fbeac539ae10ca6e557a0b589ebb66a7.pdf

Ding, R., Liu, Y., Yang, S., Liu, Y., Shi, H., Yue. X., ..., & Wu, J. (2020). High-throughput sequencing provides new insights into the roles and implications of core microbiota present in pasteurized milk. *Food Research International*, 137(109586), 1-10. https://doi.org/10.1016/j.foodres.2020.109586

Fitriyanto, Y., Astuti, T.Y., & Utami, S. (2013). Kajian viskositas dan berat jenis susu kambing peranakan etawah pada awal, puncak, dan akhir laktasi. *Journal Ilmiah Peternakan*, 1(1), 299—306. https://www.academia.edu/24067917/KAJIAN_VISKOSITAS_DAN_BERAT_JENIS_SUSU_KAMBING_PERANAKAN_ETAWA_PE_PADA_AWAL_PUNCAK_DAN_AKHIR_LAKTASI_STUDY_OF_VISCOSITY_AND_DENSITY_OF_MILK_PERANAKAN_ETAWA_PE_AT_THE_BEGINNING_PEAK_AND_END_OF_LACTATION_PERIODS

Gelagar, A. R., Fakhrurrazi., Ismail., Darniati., Rastina., & Isa, M. (2017). Pengaruh Waktu Penyimpanan Susu Sapi Pasteurisasi Pada Suhu Kamar Terhadap Jumlah koloni *Staphylococcus aureus*. *JIMVET*, 01(3), 360-365. https://jim.usk.ac.id/FKH/article/download/3346/1715

Miller, G. D., Jarvis, J. K., & McBean, L. D. (2007). *Handbook of Dairy Food and Nutrition*. New York (US): CRC Pr. https://dl.icdst.org/pdfs/files3/a4dff20c15cd88064ed76534a6139725.pdf

Hellwig, M. (2019). The chemistry of protein oxidation in food. *Angewandte Chemie, International Edition*, 58(47), 16742-16763. https://doi.org/10.1002/anie.201814144

Hendrawati, T. Y. (2017). *Membangun industri susu sterilisasi skala IKM*. Penerbit Samudra Biru (Anggota IKAPI) https://books.google.co.id/books/about/MEMBANGUN_INDUSTRI_SUSU_STERILISASI_SKAL.html?id=EBSUEAAAQBAJ&redir_esc=y

Hutagaol, F. V. A. (2013). *Kualitas mikrobiologi susu sebelum dan sesudah pasteurisasi* [Thesis]. Bogor (ID): Institut Pertanian Bogor. https://repository.ipb.ac.id/handle/123456789/61248

Incecco, P. D., Dallavalle, S., Musso, L., Rosi, V., Sindaco, M., Pellegrino, L. (2024). Formation of di-Tyrosine in pasteurized milk during shelf storage. *Food Chemistry*, 435(137566). https://doi.org/10.1016/j.foodchem.2023.137566

Indumathy, M., Sobana, S., Panda, B., & Panda, R. C. (2022). Modelling and control of plate heat exchanger with continuous high-temperature short time milk pasteurization process – A review. *Chemical Engineering Journal Advances*, 11(100305). https://doi.org/10.1016/j.ceja.2022.100305

Khoirani, K. (2015). *Uji Kualitas Susu dengan California Mastitis Test (cmt) dan Organoleptik pada Kerbau Perah (Bubalus bubalis) di Kabupaten Enrekang* [Thesis]. https://core.ac.uk/download/pdf/77624498.pdf

Le, T. T., Phan, T. T. Q., Camp, J. V., & Dewettinck. (2015). Milk and Dairy Polar Lipids: Occurrence, Purification, and Nutritional and Technological Properties. 5 - Milk and Dairy. *Polar Lipids: Biology, Chemistry, and Technology*, 91-143. https://doi.org/10.1016/B978-1-63067-044-3.50009-1

Limbo, S., Pellegrino, L., D'Incecco, P., Gobbi, S., Rosi, V., & Fracassetti, D. (2020). Storage of pasteurized milk in clear PET bottles combined with light exposure on a retail display case: A possible strategy to define the shelf life and support a recyclable packaging. *Food Chemistry*, 329(127116), 1-9. https://doi.org/10.1016/j.foodchem.2020.127116

Lingathurai, S., Vellathurai, P., Vendan, S. E., Anand, A. A. P. (2009). A comparative study on the microbiological and chemical composition of cow milk from different locations in Madurai, Tamil Nadu. Indian Journal of Science and Technology, 2(2), 51-54. https://dx.doi.org/10.17485/ijst/2009/v2i2.11

Liu, Z., & Rochfort, S. (2023). Lipidomics in milk: recent advances and developments. *Current Opinion in Food Science*, 51(7), 101016. http://dx.doi.org/10.1016/j.cofs.2023.101016

Lott, T. T., Stelick, A. N., Wiedmann, M., & Martin, N. H. (2023a). Gram-negative post-pasteurization contamination patterns of single-serve fluid milk produced in 4 different processing facilities. *J Dairy Sci*, S0022-0302(23)00708-7. https://doi.org/10.3168/jds.2023-23940

Lott, T. T., Wiedmann, M., & Martin, N. H. (2023b). Shelf-life storage temperature has a considerably larger effect than high-temperature, short-time pasteurization temperature on the growth of spore-forming bacteria in fluid milk. *J Dairy Sci*, 106(6), 3838-3855. https://doi.org/10.3168/jds.2022-22832

Maharani, M., Sudarwanto, M. B., Soviana, S., & Pisestyani, H. (2020). Pemeriksaan Kualitas Susu Asal Kedai Susu Kawasan Permukiman Mahasiswa IPB Dramaga dan Cilibende Bogor. *Jurnal Kajian Veteriner*, 8(1), 24-33. https://dx.doi.org/10.35508/jkv.v8i1.2230

Marangoni, F., Pellegrino, L., Verduci, E., Ghiselli, A., Bernabei, R., Calvani, R., …, & Poli, A. (2018). Cow's milk consumption and health: a health professional's guide. *J Am Coll Nutr*, 38(3), 197-208. https://doi.org/10.1080/07315724.2018.1 491016.

Martin, N. H., Boor, K. J., & Wiedmann, M. (2018). Effect of post-pasteurization contamination on fluid milk quality. *Journal of Dairy Science*, 101(1), 861-870. https://doi.org/10.3168/jds.2017-13339

Martin, N. H., Evanowski, R. L., & Wiedmann, M. (2023). Invited review: Redefining raw milk quality-Evaluation of raw milk microbiological parameters to ensure high-quality processed dairy products. *J Dairy Sci*, 106(3), 1502-1517. https://doi.org/10.3168/jds.2022-22416

Maryana, D., Malaka, R., & Maruddin, F. (2016). Karakteristik fisiko-kimia dan organoleptik susu pasteurisasi dengan penambahan ekstrak daun binahong (*Anredera cordifolia* (Ten) Steenis) dan Sukrosa. *Jurnal Sains dan Teknologi*, 16(2), 107-112 https://www.researchgate.net/publication/331533976_KARAKTERISTIK_FISIKO-KIMIA_DAN_ORGANOLEPTIK_SUSU_PASTEURISASI_DENGAN_PENAMBAHAN_EKSTRAK_DAUN_BINAHONG_Anredera_cordifolia_Ten_Steenis_DAN_SUKROSA

McCarthy, O. J. (2022). Physical and Physico-Chemical Properties of Milk. *Encyclopedia of diary sciences (Third edition)*, 603-614. https://doi.org/10.1016/B978-0-12-818766-1.00334-2

Melia, S., Purwati, E., Yuherman., Juliyarsi, I., Ferawati., Purwanto, H. (2018). Susu Potensi Pangan Probiotik. Andalas University Press. Padang. http://repo.unand.ac.id/40075/1/SUSU%20POTENSI%20PANGAN%20PROBIOTIK.%20Sri%20Melia%20Endang%20Purwati%20Yuherman%20Indri%20Juliyarsi%20Ferawati%20Hendri%20Purwanto.%20%5B24343%5D.pdf

Milkotester. (2017). *Operating Instruction Milk Analizing Device: Master Pro.* http://milkanalyzer.eu/wp-content/uploads/2017/04/milk-analyzer-Master-Classic operating-instructios-.pdf

Mourad, G., Samir, M., & Bettache, G. (2014). Composition and nutritional value of raw milk. *Biological Sciences and Pharmaceutical Research*, 2(10), 115-122. http://dx.doi.org/10.15739/ibspr.005

Muchetti, G., Gatti, M., & Neviani, E. (1994). Electrical conductivity changes in milk caused by acidification determining factors. *Journal of Dairy Science*, 77(4), 940-945. https://doi.org/10.3168/jds.S0022-0302(94)77029-6

Muchtadi, T. R. (2019). *Pengetahuan Bahan Pangan*. Tangerang Selatan: Universitas Terbuka. https://pustaka.ut.ac.id/lib/pang4210-pengetahuan-bahan-pangan/

Mukhtar, A. (2006). *Ilmu Produksi Ternak Perah*. Surakarta LPP UNS dan UNS Press. Surakarta https://unsla.uns.ac.id/neounsla/index.php?p=show_detail&id=4806&keywords

Murti, T. W. (2016). *Pasca Panen Susu*. UGM Press. Yogyakarta. https://ugmpress.ugm.ac.id/id/product/peternakan/pascapanen-susu

Myer, P. R., Parker, K. R., Kanach, A. T., Zhu, T., Morgan, M. T., & Applegate, B. M. (2016). The effect of a novel low temperature-short time (LTST) process to extend the shelf-life of fluid milk. *Springerplus*, 5(1), 660. https://doi.org/10.1186/s40064-016-2250-1

Navyanti, F., & Adriyani, R. (2015). Higiene sanitasi, kualitas fisik dan bakteriologi susu sapi segar perusahaan susu x di Surabaya. *Jurnal Kesehatan Lingkungan*, 8(1), 36-47. https://pdfs.semanticscholar.org/45fe/bbe0cee1cc365be2ef17e07642f0d9e70263.pdf

Nirwal, S., Pant, R., & Rai, N. (2013). Analysis of milk quality, adulteration and mastitis in milk samples collected from different regions of Dehradun. *Int. J. PharmTech Res*., 5(2), 359-364 https://www.researchgate.net/profile/Rakesh-Pant-2/publication/239937856_Analysis_Of_Milk_Quality_Adulteration_And_Mastitis_In_Milk_Samples_Collected_From_Different_Regions_Of_Dehradun/data/00b4951c33a7ad75ca000000/11359-364AJ13.pdf

Nurmayanti. (2016). *Komposisi susu segar dari sapi perah penderita mastitis subklinis di Peternakan Kunak Kabupaten Bogor* [Thesis]. http://repository.ipb.ac.id/handle/123456789/84079

Pawde, S. V., Chaudhari, S. R., & Matche, R. S. (2023). Micro perforation based smart label to guide freshness of pasteurized milk packet. *Food Control*, 151(109783). https://doi.org/10.1016/j.foodcont.2023.109783

Riski, P., Prwanto, B. P., & Atabany, A. (2016). Produksi dan Kualitas Susu Sapi FH Laktasi yang Diberi Pakan Daun Pelepah Sawit. *Jurnal Ilmu Produksi dan Teknologi Hasil Peternakan*, 4(3), 345-349. https://journal.ipb.ac.id/index.php/ipthp/article/download/14632/10828

Rashid, A., Javed, I., Ayaz, M., Abdullah, M., Saeed, F., Yousuf, M. R., ..., & Anjume, F. M. (2019). Probing the physicochemical and sensorial properties of pasteurized milk via nanoparticles. *International Journal of Food Properties*, 22(1), 825–842. https://doi.org/10.1080/10942912.2019.1607374

Rosadi, A. I. (2017). *Kualitas Fisik, Kimia, dan Mikrobiologi Susu Pasteurisasi yang dikemas menggunakan Metode Pengisian Panas (Hot Filling) pada Suhu Penyimpanan berbeda di Balai Besar Pelatihan Peternakan (BBPP) Batu* [Thesis]. http://repository.ub.ac.id/id/eprint/1324/7/Ayu%20Irhoni%20Rosadi.pdf

Ritota, M., Costanzo, M. G. D., Mattera, M., & Manzi, P. (2017). New trends for the evaluation of heat treatments of milk. *J Anal Methods Chem*, 1864832. https://doi.org/10.1155/2017/1864832

Saleh, E. (2004). *Dasar Pengolahan Susu dan Hasil Ikutan Ternak*. https://web.archive.org/web/20101227002829/http://library.usu.ac.id/download/fp/ternak-eniza2.pdf

Sudarwanto, M. (2012). *Pemeriksaan Susu dan Produk Olahannya. Buku Pegangan*. Bogor (ID). IPB Press. https://skhb.ipb.ac.id/pemeriksaan-susu-dan-produk-olahannya/

Suhaillah, L., & Santoso, T. R. (2018). Analisa Cemaran Bakteri *Coliform* Pada Susu Sapi Murni dengan variasi lama penyimpanan daam suhu frezer dan suhu kulkas di Desa Wiayut Sukodono Sidoarjo. *Jurnal Sains*, 8(15), 44-49. https://journal.unigres.ac.id/index.php/Sains/article/view/798

Susilorini, T. E., & Sawitri, M. E. (2006). *Produk Olahan Susu*. Jakarta (ID): Penebar Swadaya. https://core.ac.uk/display/296541928

Wanniatie, V., & Hanum, Z. (2015). Kualitas Susu Pasteurisasi Komersil. *Jurnal Agripet*, 15(2), 92-97. https://doi.org/10.17969/AGRIPET.V15I2.2724

Warni. (2014). *Kualitas Susu Sapi Perah di Kabupaten Sinjai dan Kaitannya dengan Infeksi Listeria monocytogenes. Skrpsi. Fakultas Peternakan* [Thesis]. http://repository.unhas.ac.id/id/eprint/22194/1/--warni-2967-1-14-warni-5.pdf

Winarno, F. G. (1993). *Pangan: gizi, teknologi, dan konsumen*. Gramedia Pustaka Utama. https://lib.ui.ac.id/detail.jsp?id=11896

Wulandari, Z., Taufik, E., & Syarif, M. (2017). Kajian Kualitas Produk Susu Pasteurisasi Hasil Penerapan Rantai Pendingin. *Jurnal Ilmu Produksi dan Teknologi Hasil Peternakan*, 5(3), 94-100. https://doi.org/10.29244/jipthp.5.3.94-100

Yang, S., Li, X., Cang, W., Mu, D., Ji, S., Wu, R., & Wu, J. (2023). Combined treatment of ε-polylysine and thermosonication to inactivate Bacillus cereus and their application in pasteurized milk. *J Food Bioscience*, 55, (103116), https://doi.org/10.1016/j.fbio.2023.102896

Yudonegoro, R. J., Nurwantoro., & Harjanti, D. W. (2014). Kajian Kualitas Susu segar dari Tingkat Peternak Sapi Perah, Tempat Pengumpulan Susu dan Koperasi Unit Desa Jatinom di Kabupaten Klaten. *Animal Agriculture Journal*, 3(2), 323-333. http://ejournal-s1.undip.ac.id/index.php/aaj

Zhao, Y., Zhao, H., Li, L., Tan, J., Wang, Y., Liu, M., & Jiang, L. (2023). Multi-omics analysis reveals that the metabolite profile of raw milk is associated with dairy cows' health status. *Food Chemistry*, 428(136813). https://doi.org/10.1016/j.foodchem.2023.136813.