

Conference Paper

Cheese Whey Wastewater: Characterization and Value

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Abstract.

Cheese whey is the liquid that results from the coagulation of milk during cheese manufacture. To produce 1 kg of cheese, 10 L of milk is needed, originally 9 L of cheese whey and in case disposed of without treatment. It creates a significant problem for the environment. The research aims to find out the environmental impact and the potential of whey from Yogyakarta as a useful product. The materials used in the study used cheese whey from Cangkringan Yogyakarta. The parameters of the cheese wastewater were pH, BOD₅, COD, TSS, TDS, NH₃-H, and the physicochemical analyses targeted the protein, lactose, and fat, based on regulatory quality standards by the Ministry of Environment of the Republic of Indonesia No. 5 of 2014, concerning wastewater quality standards. The results show that TSS of 45,500 mg/L, pH of 5.9, BOD₅ of 19,900 mg/L, COD of 90,000 mg/L, TDS 3440 mg/L, NH₃-H 42,19 mg/L, protein 2.75%, lipid 0.054%, lactose, 4.1%. We can conclude that the value of BOD and COD, NH₃-H in cheese wastewater does not contain good quality water, but on the other hand, whey had good potential for functional food ingredients indicated by protein, lipid, and lactose value. Due to its proven protein, lipid, and lactose value obtained in the study can be used as a functional food ingredient.

Keywords: pollution, cheese whey, wastewater

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1. Introduction

The cheese factory is increasing quickly factory in Indonesia. X Cangkringan is one of the cheese industries in Indonesia. Cheese whey is the liquid that results from cheese manufacture [1]. Whey is The liquid that remains after milk has been strained and curdled. Whey is the liquid residue of cheese. Cheese Whey is a yellow-green color liquid [2]. Cheese whey has a high nutritional value [3]. In general, the whey component contains around 55% of the nutrients from milk [4]. Whey is a major source of environmental pollution due to the bulk qualities and its high organic load [5]. Whey components are

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difficult to degrade and create a major problem to any wastewater treatment plant that treats other effluents.

Cheese whey mainly contains, water, lactose, fat, and protein [6]. According to the method of milk protein coagulation, whey is divided into types: sweet whey and sour [7]. Sweet whey is produced from the process of making cheese using rennet to coagulate casein or proteolytic enzymes with a pH=6-7. Sour whey is produced from the process of making cheese in addition to organic or mineral acids for casein with a pH <5 [8]. The first step in the production of cheese is the addition of rennet, to milk. The rennet works by curdling the casein protein in the milk. The curd are filtered from the remaining liquid. This is known as whey [9]. The cheese industry produces vast volumes of aqueous waste. Production of 1 kg of cheese, approximately 8-9L of whey is produced. The quality of whey is correlated to the productivity of cheese [9]. Whey components are difficult to degrade and create a major problem to any wastewater treatment [5].

Whey production is currently increasing by 2% annually on a global scale, along with the growth of milk and cheese production [6]. Cheese industries have supplied large amounts of whey [10]. The cheese industry generated approximately 115 million tons of whey a year [11]. Cheese whey can cause an environmental impact when the liquid waste generated by this industry is not managed effectively [7]. It is estimated that 4000L of whey could cause environmental risk equal to that caused by fecal pollution produced by 1,900 persons [11].

Cheese whey is the major pollutant generated by the cheese industry [12]. Whey pollutants a source of organic matter, mineral salt, salinity, acidity, nutrients, total suspended solids (TSS), etc. Whey has a high biological oxygen demand (BOD) and chemical oxygen demand (COD) [13]. Lactose is the major component causing high BOD and COD levels in cheese whey [14]. Whey has BOD and COD value that range from 40000-60000 mg/L and 50000-80000 mg/L [11]. In general, High BOD and COD values can cause several environmental risks [5]. BOD and COD values are crucial for determining the level of water contamination [15].

Many studies have been done on cheese from Indonesia, but the environmental effects of whey cheese made from Cangkringan Indonesia and the ways to reduce it have not been considered. One of the problems of whey for use in the cheese industry is the high organic load, volume generated also perishability [9]. This study aims to find

out the environmental effects and potential of reducing whey cheese from Cangkringan Yogyakarta as a useful product.

2. Methods

2.1. Study design

This research use observational research which is descriptive in nature. The approach of collecting data was carried out in numerous steps, called the observation of the research location, having discussions with informants, collecting samples for characterization, and physicochemical parameter analysis.

2.2. Sample

Cheese whey was obtained from X factory cheese in Cangkringan, Yogyakarta, Indonesia. Samples were taken in 1.5L plastic bottles with closed caps. Whey samples were collecting using bottle samples for physicochemical parameter analysis which explains the wastewater sampling method. The samples were evaluated for characterization (COD, TSS, TDS, Ammonium-total, TSS, TDS) in the Laboratory of BPKLPP Yogyakarta. The samples were evaluated for physicochemical parameter (protein, lipid, and lactose) analysis at the Universitas Sebelas Maret.

2.3. Data collection procedure

These analyses targeted the pH, BOD₅, dry matter content, COD, TSS, TDS, Ammonium-total (NH₃-H), protein, lipid, and lactose, as described below. The parameters of the cheese wastewater to be analyzed, BOD, COD, TSS, pH. Based on regulatory quality standards Minister of Environment of the Republic of Indonesia No. 5 of 2014 concerning Wastewater Quality Standards. Physicochemical parameter analysis TSS using gravimetric analysis (SNI 6989.3:2004), pH value using a digital pH meter (SNI 06-6989.11-2004), BOD₅ using Winkler with 5 days incubation time (SNI 6989.72.2009), COD using the close reflux titrimetric method (SNI 06-6989.2-2009), Analysis of protein and lipid using AOAC (11), lactose analysis using lactoscan.

2.4. Data analysis

The data obtained compared with water quality standards waste in attachment XVIII of Ministerial Regulation Environment of the Republic of Indonesia No.5 tahun 2014, concerning wastewater Quality Standards, for Business and/or Activities cheese making. The data obtained were descriptivel.

3. Results

The result of physicochemical parameters of cheese whey testing laboratory can be seen in Table 1. Table 1 shows that value physicochemical parameters of for whey from cheese and quality standards PPLHK 2014. Result present in Tabel 1 show that of the parameters tested, including BOD₅, COD, TSS, TDS, NH₃-H, pH. The test results showed the concentration of whey from cheese factory that still do not meet the quality value.

TABLE 1: Physicochemical Parameters of Cheese Whey.

Samples	Parameters	Standards	*Quality standards
BOD ₅	mg/L	19900	50
COD	mg/L	90000	100
TSS	mg/L	45500	200
TDS	mg/L	3440	NR
Ammonium-total (NH ₃ -H)	mg/L	42,19	10
pH	-	5,9	6 – 9

Note: *PPLHK RI no 5. 2014 [16].
 NR = not reported in the original literature
 BOD = Demand Biological Oxygen Demand
 COD = Chemical Oxygen Demand
 TSS = Total Suspended Solids
 TDS = Total Density Solids

Table 2 shows the average composition of cheese whey from X Cangkringan cheese industry. The table 2 shows whey cheese contains protein, lipid, and lactose. The average result were shows in table 2, 2.75(w/v)% protein, 0.05% lipid, 4.1% lactose.

TABLE 2: The average composition of cheese whey.

Protein	Lipid	Lactose
%	%	%
2.75	0.05	

4. Discussion

Cheese Factory is one of the factories fast growing in Indonesia. X cheese factory is a significant development of the cheese Industry. In X factory raw material for cheese production is cow's milk. The steps in making cheese is addition enzyme rennet to milk. During cheese-making, rennet was used to coagulate the milk. The casein protein in the milk is curdled by the rennet, resulting in the creation of curds. The curd is filtered from the residual liquid. The residual liquid is called whey. This industry produces 1.956 kg of cheese per mount. This industry needs milk to produce 13.980 liters per mount. The volume of whey discharged into the environment is 11.156 liters per mount. High demand for cheese causes the amount of whey to increase. X cheese factory does not process their liquid waste before discharging it into the environment, this will certainly contaminate the ecosystem. Whey in Indonesia is still considered water waste. The central problem associated with whey is that it has the potential to harm the environment.

The following data is the result of an analysis of whey cheese quality in the X cheese factory. The parameters that were tested include value BOD, COD, TSS, TDS, and ammonia nitrogen. The physicochemical analyses targeted the protein, lactose, and fat.

Based on table 1 shows that BOD_5 is 19.900 mg/L. KLH No. 05/2014 which states that the quality standard for BOD_5 content is 50 mg /L. It is known that cheese wastewater content does not meet the quality standard requirement, if it is directly discharged into water bodies. Whey cheese can pollute. Whey cheese certainly has an impact on the surrounding ecosystem. BOD is a parameter for evaluating the amount of oxygen required by the activity of microorganisms to biodegrade organic substances in water waste. The BOD of whey cheese is very high. BOD is an indicator of organic pollution in waters [17]. High-value BOD_5 concentration signals the number of pathogenic microorganisms. Pathogenic microorganisms can cause various diseases in humans [18].

Based on table 1 shows that COD value of 90.000 mg/L. PPLHK No. 05/2014 which states that the quality standard for COD value is 100 mg /L. It is known that COD whey does not meet the quality standard requirements. High-value COD indicated a number of organic compounds in the water. COD value is higher than BOD. These two indicators indicate the value of oxygen in the water which is related to the value of the organic matter in the water [19].

The number and activity of microorganisms have a significant effect on the value of BOD when the number of microorganisms is small, the process of biochemical breakdown does not occur or intensity of biochemical breakdown does not occur significantly. In natural conditions, such an effect is often caused by presence of toxic compounds that adversely affect the enzymatic activity of the microorganisms. In that case, it must be considered that the changed values of BOD do not reflect the actual level of water pollution [20].

Based on the table 1. shows that TSS, TDS, and ammonia nitrogen have not met the quality standard. Whey can be toxic to anaerobic microorganisms because it inhibits their growth, affecting the removal of BOD and COD [21]. Based on table 1. indicate that cheese waste products have a massive impact on water pollution. These wastes are very dangerous for the environment. Cheese whey has essential to polluting water including groundwater. Water pollution causes disaster to society. Cheese whey is harm the soil. Cheese whey is dumped through land spreading causes chemicals (salts) can accumulate in the soil. Whey application can also lower the redox potential of the soil. This can cause the solubilisation of Mn and Fe in the soil potentially contaminating groundwater sources [22]. Whey was a major issue for dairy facilities only a few decades ago. It had not been recycled to the extent that it is now. Whey, along with sewage, was removed because of organic compounds it contained, which constituted a hazard to the ecosystem.

Based on table 2. whey contains an important nutritional value compounds, such as lactose, protein, and lipid. Whey is an excellent source nutritious liquid, containing whey Proteins, lipids, and lactose, that could be exploited by biotechnological, medical and agri-food. lactose is a crucial element in infant formula and in food processing. Based on table 2 shows that lactose value of 4,1%. Lactose, the main primary component of cheese whey, representing 70-75% the total solids. Lactose is cause for the high values for BOD and Cod[2]. Lactose is the main ingredient of whey. Most milk carbohydrates move into the whey after cheese manufacturing of which 90% is lactose including some glucose, oligosaccharides, galactose, and amino sugars. Lactose is essential source of energy. Lactose has a lot of benefit aspects. Whey has lactose as its most abundant ingredient. Lactose has the characteristic difficultly digested by part of the humans[23]. The lactose need break down by the enzyme lactase. The process of lactose hydrolysis is crucial on an industrial since it enables the creation of products. Lactose can be used as a sweetener [23]. Lactose can be use as a sweetener for diabetic[22]. lactose,

protein, and fat are potentially complete substrates for cultivation of microorganisms[2]. The lactose component in cheese whey can be effectively to lactic acid using a culture of *Lactobacillus* microba culture[24]. Lactose from whey can also be utilized to make Galactooligosaccharides (GOS). These are probiotics that can improve human health by stimulating the growth of probiotic bacteria in the stomach[22].

Based on table 2 shows that whey cheese in Cangkringan contains protein 2.75 %. Protein is important component in whey. The essential whey proteins are immunoglobulins, α lactalbumin, bovine serum, albumin, and proteose-peptone [22]. Whey proteins nutritional value is well known. The biological value of the whey is higher than that of the egg [25], and soybean [26].

Based on the study and our result, whey has a high nutritional value and its consumption positively impacts body functions [27],but the high content of nutrients in post-production stream is damage for environmental. Based on the positive value of whey, new products have been discovered and this resulted in minimizing the overall waste of whey. Whey could be exploited by biotechnology. Biotechnology reduces the amount of whey by reusing whey as a raw material for products.

5. Conclusion

Cheese whey can cause an environmental impact. Value of BOD, COD, NH₃-H and TSS in cheese water waste do not have good water quality, but another the hand Whey had good potential for functional food ingredients indicated by protein, lipid, and lactose value. Additional studies on innovative uses of whey will be essential to develop functional beverages products.

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Conflict of interest

The authors have no conflict of interest to declare.

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