Exploration of Pulp and Husk of Gayo Arabica Coffee as Raw Material of Pectin – SWOT, Risk and Chemical Component Analysis

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Abstract
Advances in waste management offer huge possibilities for economic and social utilization of residues from coffee production such as the pulp and husk. Coffee pulp are obtained during coffee production around 20-45% of raw material either it processed wet or dry. In Gayo Highland areas, as a centre of Arabica production in Indonesia, coffee production known as semi-drying process where numbers of coffee residues arise up to 40% of total coffee berries. For local farmers pulp and husks often be decompose by burning, whether several alternatives have been attempted individually, either used as fertilizer, livestock feed and compost. However the applications above cover only small number of robust coffee residues. Therefore studies have been conducted to explore possibility to extract pectin from coffee pulp. Implementation of SWOT analysis and Risk Analysis by FMEA gain to enhance the information of strength, weakness, opportunity and threats of extraction pectin from coffee pulp/husks demonstrated that this attempt have higher possibility to be more efficient than others trial for both economically and ecologically. Furthermore, moisture contents, ash and crude fiber are examined from fresh pulp/husk which are stored in room temperatures for 16 days, 24 days and 30 days. The data demonstrated that length of storage up to 30 days has impact on increasing ash (up to 12.66% from 1.38%) and solid fiber contents (up to 28.24% from 2.70%) whilst moisture are decreased (down to 15.51% from 86.08%) which emphasizes that delaying production or prolonging the storage of coffee residues might not have any impact on product quality.
Key words: Gayo Highland, Arabica coffee, coffee pulp, husk, mucilage, pectin.

Introduction

Fresh coffee cherries are described as small round and reddish green berries. Coffee processing transforms coffee cherries into green bean by ratio 6:1 (6 kg fresh cherries to have 1 kg green bean (ITC, 2015a). Global coffee production counted as green bean in 2014 reach out up to 141.800 thousand bags, where Indonesia supported 90.000 thousand bags (ICO, 2015b). On the other hand, total world consumption was 149. 265 thousand bags in 2014 where mostly coming from importing countries such as EU, USA, Japan and Russia (ICO, 2015). The numbers shows impressive demands in coffee which triggers farmers to produce intensively as well as produces abundant by products to handle. By assuming this, there are need to optimalise the robust numbers of waste, especially pulp that has highest percentage.

Pectin defines as water soluble carbohydrate which normally known as plant fiber, commonly used in food industry as food additive to enhance texture, viscosity and stability such as jelly, jam, marmalade etc (Chaubey and Kapoor, 2001; Whillet et *al.,* 2006). By refers to trials in cacao pulp, this research attempts to produce pectin from coffee as well as said by Avellone et al (1999) pulp and mucilage from coffee contains high numbers of pectin, sugars and protein.

Materials and Methods

Coffee pulp taken from Desa Geleulungi Kecamatan Pegasing Aceh Tengah districts three times (20th May; 2nd May and 25th April 2015). Fresh coffee pulp then is cleaned, weighed, and packaged in fold-clipped vacuum transparent plastic then stored for 16 days, 24 days and 30 days in dark - room temperature.

Procedure

Coffee pulp then analyzed the moisture contents oven method (Sudamadji et *al.,* 1997), ash contents (AOAC, 1997) and crude fiber contents (Apriyantono*,* 1989). Another exploration methods carried out by SWOT Analysis continued with FMEA (adopted from Soerensen, 2004; Yin, 2009). The study based on literature reviews towards update research of pectins and uses of coffee pulps. The data is

searched, collected, mapped based on SWOT and then counted the risk based Risk Priority Number (RPN) as well as recommendation actions should be listed. All of data was searching based on research questions "the possibility of using coffee pulp as raw material of pectin".

Failure Mode Evaluation Analysis (FMEA) as supportive tools to analyze occurrences factors, (possibility errors to be occurs), severity (the impacts) and detection (inability to detect the error) for all the failures, then counted the RPN, as the sum up of multiplication of these three aspects of FMEA. Measurement scale of FMA could be seen in Table 1.

Table 1. FMEA scale measurement (

FMEA Measurement	Skala	Deskripsi Skala
Occurences/Probability (O/P)	1	Failure is unlikely
	2/3	Relatively low failures
	4/5/6	Moderate (occasional failures)
	7/8	High (repeated failures)
	9/10	Very high (failure is almost inevitable)
Severity (S):	1	No severity
	2	Very minor (be unnoticed and have only minor effect on performances)
	3	Minor (cause minor nuisance but can overcome with no performance)
	4/5/6	Low to Moderate (casue minor perfomance loss up to partial malfunction)
	7/8	High, casue extreme malfunction and dissatisfaction consumer
	9/10	Very high and hazardous for health
Detection (D):	1	Very easy to detect
	2	High ability to control failures
	3	Moderate
	4/5/6	Moderate – high consumer loss
	7/8	Low ability to detect failures
	9/10	Very difficult tp detect failures

Sources: Janssen (2010); Mc. Dermot et *al.,* (199)

Results and Discussion

SWOT analysis carried out the strength, opportunity as well as pointed out the weakness and threats of of using coffee pulp as raw material of pectin. As shows in Figure 1 Aceh Tengah district as centre production of Arabica coffee in Indonesia has potential resources of coffee pulp in low prices, which considers as waste by the farmers at the moment. According to Bressani et *al.,* (1972) each 1000 kg coffee berries produces 43% pulp, 38% coffee beans, 11.8% mucilage, and 6.1% hulls. Therefore when reported in 2012 Aceh Tengah produced 26.163 tons of coffee (BPS, 2013) 43% (11.250 tons) of it are coffee pulp. On the other hand, research showed high interest of Aceh Tengah farmers to utilize the coffee waste as fertilizers (PSI, 2015), cattle feeding (Daud et *al.,* 2013; Usman et *al.,* 2013) or media plantation (PSI, 2015). Moreover innovative research developed particleboard from this by products (Odih, 2009; Safriana, 2012).However these attempts could not accommodate high numbers of coffee waste available.

Commercial pectin usually produced from citrus peel and apple pomade (Food Navigator, 2014). Reports mentioned that pectin from material above commonly used in food production and becoming tight in prices on raw material shortage and supply chain problems. On the other hand demands on pectin supply in Indonesia and Asia globally steadily increased. BPS (2010) and Chahyaditha (2011) assumed that Indonesia imports 289.12 tons pectin a year where Asia requires 24.315 tons a year. Since Indonesia still lack of pectin manufacturer pectin consumes high cost.

Threats and weakness mentioned challenges and lack of resources to obtain the goal of production pectin from coffee pulp. Recent research showed extraction of water soluble carbohydrate from coffee pulp with water produced yield 10,98% with pectin fiber 57,24% (Diniyah et *al.,* 2013) by temperature variation and coffee varieties. The results also showed that pectin have darker color and unattractive (Ningsih, 2013). Further researches found out using chloric acid, acetic acid (Satria & Auda, 2008), ammonium sulfic (Syukra, 2007) and oxalate acid (Utami, 2014). Furthermore Nazaruddin and Asmawati (2014) pointed out that cacao pulp that extracted with ammonium oxalat

have pectin with yield 17,82% which out higher than conventional methods 0,6-1,46% (Belfrid, 1995).

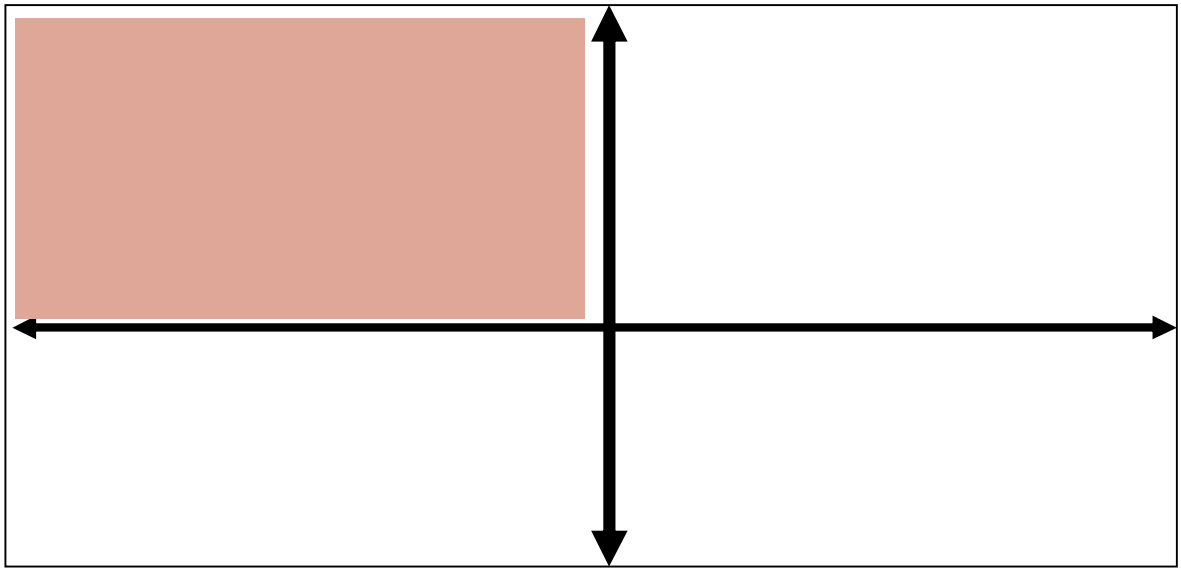

Figure 1. SWOT Analysis of possibility coffee pulp as pectin material

Analysis continued with performance of FMEA analysis like Table 2 below. There are two major problems related to unknown method or technology used in order to collect optimum extraction yield and competition from established brands. Following actions suggested that intensive research should be done in order to find out all information needed, as well as training and assistances for farmers to implement and adapt with technology.

Table 2. Technical problems with FMEA measurement and recommended actions

Problems	Impacted Parties	Causes	FMEA			RPN	Recommended Actions	Level of Investments	
			O	S	D			(1) Low	(2) High
Mass equilibrium unknown Optimum extraction methods unknown	Farmers	There is no standard production method of pectin from coffee pulp yet	7	3	3	63	Adoption of Asmawati and Nazamuddin (2015) methods to extract pectin from coffee pulp		1
Low input technology for small scale farmers unknown		Complexity of pectin production (stages and supportive materials)	7	4	3	84	Pilot plants		1
		Farmers education and knowledge	4	2	2	16	Training and assistances		2
Competition from similar products		Quality of pectin from coffee pulp not yet known	5	3	3	45	Review and comparing the quality with established commercial pectin known		2

Furthermore moisture contents, ash and crude fiber are examined from fresh pulp/husk which are stored in room temperatures for 16 days, 24 days and 30 days. The data demonstrated that length of storage up to 30 days in room temperature has impact on increasing ash (up to 14.99% from 9.91%) and crude fiber contents (up to 33.44% from 19.48%) whilst moisture are decreased (down to

15.52% from 86.09%) which emphasizes that delaying production or prolonging the storage of coffee residues might not have any impact on product quality. Moreover the drying process of coffee pulp could be recommended as preventive action to avoid microbial growth.

Table 2. Changes of dietary fiber, ash and moisture contents of fresh coffee pulp during storage

Length of storage	Crude fiber (%)	Ash contents (%)	Moisture Contents (%)
	Mean	Mean	Mean
16 days	19.48 ± 0.73	9.91 ± 0.02	86.09 ± 0.39
24 days	27.73 ± 0.13	11.48 ± 0.03	18.61 ± 0.34
30 days	33.44 ± 0.67	14.99 ± 0.13	15.52 ± 0.08

Conclusions

Taking everything into consideration pectin production considers as effective trial to utilise the availability of coffee pulp in Aceh Tengah. However intensive research towards the extraction methods required to be done, especially by adoption of Nazaruddin and Asmawati 2014) methods.

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