Advance Journal of Food Science and Technology 6(5): 701-706, 2014
DOI:10.19026/ajfst.6.97
ISSN: 2042-4868; e-ISSN: 2042-4876

Submitted: February 28, 2014 Accepted: April 17, 2014 Published: May 10, 2014

Research Article

Model Formulation of Apple Beverages for Production System in Micro Small Scale Enterprises (MSEs) Using Generalized Structured Component Analysis (GSCA) Method

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Abstract: The goal of this study is to determine the model formulation of the production systems of apple beverages by including the quality of apple, the level of food additives, the condition of pasteurization and the quality of apple beverages. The sample of this research is Micro Small Scale Enterprises (MSEs) of apple beverages in the Batu city, East Java Province using a sample of 20 people as the owners or production staff in MSEs. The methods of analysis is Generalized Structured Component Analysis (GSCA) that the news model for measuring effect and corelation of latent variable in model. The results showed that the model is feasible to explain 35.7% of the variation in the quality of apple beverages. The condition of pasteurization had a significant effect at the 5% level (p-value <0.05), while the other variables (the quality of apples and the level of food additives) had no significant effect on the quality of apple beverages. The novelty of this study that the quality of apple, the level of food additives, the condition of pasteurization and the qualty of apple beverages can expresion in the matematic model with GSCA analysis. The limitation of this study is that other variables in the apple beverages production not included in the model such as extraction, sterilization which one also critical in the production.

Keywords: Apple beverages, model, production

INTRODUCTION

Based on the report issued by the Ministry of Industry and Trade of the Republic of Indonesia in Batu city, East Java Province in 2002 showed that Micro Small Scale Enterprises (MSEs) were one of the support of the regional economy based on the utilization of natural resources of the local area. In the year of 2006, the role of MSEs for the creation of the national gross domestic product in current prices amounted up to IDR. 1778.75 trillion or 53.28% of total national Gross Domestic Product. Fruit juice is one of the instant products that can be consumed as soft drinks with a prospective consumer demand. The mmanufacture of soft drinks including fruit juice has been growing more rapidly than fast food in Western societies (Endrizzi *et al*., 2009) and even possesses a highly competitive products such as a health drinks not only because of the taste and nutritional properties, but also because of an effects on health (Muntean and Nicoleta, 2010). Furthermore it also has a potentia in the innovation and rapid development (Jayalakshmi *et al*., 2011). Apple beverages are one of the potential products of the apple processing industries in Batu city.

Apple beverages are produced by MSEs in Batu city, using 3 varieties of apple namely Manalagi, Anna and Romebeauty with an addition of sugar and water as the main ingredients. Production system in MSEs varies in the use of raw materials, food additives, the implementation process and the determination of the final quality to be able to reach various market segments. The diversity of processes at the manufacturers has an impact on the diversity of products and satisfaction (Parasuraman *et al*., 1994) to meet the expectations and demands of the consumers (Oliver, 1993; Arnould *et al*., 2005). Direct impact on consumer's satisfaction as a result of the variation in the production process, reflected by the variation in the quality of products which include differences in taste, color, flavour leading to differences in prices to reach consumer segments. Establishing a standardized production in process by including a formulation of apple beverages is mportant to produce optimum quality products that can meet both the producer (MSEs) and consumers satisfaction.

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There are several factors affecting the diversity of the apple beverages, such as the quality of apples, the level of food additives, the condition of pasteurization and the quality of beverages. Apple quality can be categorized by grade and maturity (Prihatman, 2000). Types and quantity of food additives used by different MSEs resulted in various qualities of apple beverages such as taste, color, flavor and consequently the differences in price. The use of food additives must follow the Ministry of Health of the Republic of Indonesia Number 033 of 2012 and the regulation of Food and Drug Regulatory Agency Number 27 in 2013 and Codex General Standard For Food Additives Codex Stan 192-1995, Rev. 7-2006 about preservative, acidity regulator, sweetener and flavour.

The diversity of the production process are also seen in thermal pasteurization process conducted by MSEs. Pasteurization is used to reduce the levels of pathogenic microbes (Olubukola *et al*., 2011) to extend the shelf life of beveragess (Gandolfi *et al*., 1994; Kisko and Roller, 2005; Court, 2009; Maji *et al*., 2011; Torkamani, 2011) as well as to maintain sensory products (Baldwin, 2012). At this moment there is no standard of optimum pasteurization temperature and time for fruit juices in Indonesia. The need for the optimum temperature is to inhibit the growth of microbes and to extend shelf life (Sahota *et al*., 2010). The quality of apple beverages refers to the quality standards for taste, flavors and dissolved solids and the use of food additives (preservatives) as regulated in Indonesian National Standardization 01-0222-3719-1995.

Based on the diversity in the production proces in the MSEs, it is improtant determine of standardized apple beverages production from the use of raw material, the level of food additives, the conditions of pasteurization and the adjustment of product quality. Standard setting process quality apple beverages is started with analysis of the effects and relationships among the variables involved in the formulation of the model between the quality of apples, the level of food additives, the optimum condition of pasteurizaton and the quality of apple beverages. Research on the quality of the raw material (apple), the level of food additives, the condition pasteurization and quality of apple beverages were partial and limited, therefore a more comprehensive survey on the interrelationships among several factors that the quality of apple beverages in the form of quantitative models is needed. In the present study, the process standardization of the apple beverages was developed in a model involving potential variables such as raw materials (apple), food additives, the optimum condition of pasteurization and product quality. In addition, the relationship among them was predicted using the method of the Generalized Structured Component Analysis (GSCA).

GSCA is a new method of Structural Equation Modelling (SEM) based components that can be used for the measurement model (relationships between latent variables with indicator) with a reflexive and or formative indicators and the structural model (relationships between latent variables) with very small samples (Loehlin, 2004). SEM analysis of component based GSCA is a better alternative than the Partial Least Squared (PLS) because it has a better recovery parameters (Hwang, 2009; Hwang *et al*., 2010). The results of the analysis GSCA described the relationship and influence between the quality of raw materials (apple), the levels of food additives and the condition of pasteurization on the quality of apple beverages. The goal of this study is to determine the model formulation of the production systems of apple beverages include the quality of apple, the level of food additives, the condition of pasteurization and the quality of apple beverages.

MATERIALS AND METHODS

This study is part of the engineering decision support system for process optimization model standardization of apple beverages in MSEs in Batu city, East Java Province.

The targeted population of the research is MSEs apple beverages producing in Indonesia, the accesed population is MSEs for apple beverages producers in Batu city, East Java Province. Data issued by the Department of Cooperatives Small Medium Enterprises, Industry and Trade of Batu City, between 2011-2012 there were 20 MSEs producing apple

Table 1: Items of instruments of the research

Variablee	Indicator	Scale of measurement	Unit
The quality of apple (X1)	Grade of apple (X1.1)	Ordinal	Score (1-5)
	Acid content (X.1.2) and total sugar (X.1.3)	Ratio	%
		Ratio	%
The level of food additives-1 (X2)	Preservative (X2.1)	Ratio	ppm
	Sweetener (X2.2)	Ratio	
The level of food additives-2 (X3)	Acidity regulator (X3.1)	Ratio	
	Flavour enhancer (X3.2)	Ratio	
The condition of pasteurization (Y1)	Temperature (Y1.1)	Ratio	°C
	Time (Y1.2)	Ratio	min
The quality of apple beverages (Y2)	Acid content (Y2.1)	Ratio	%
	Total dissolved solid (Y2.2)	Ratio	°Brix
	Total sugar (Y2.3)	Ratio	%
	Flavour (Y2.4)	Interval	Score (1-5)
	Taste (Y2.5)	Interval	
	Color (Y2.6)	Interval	

beverages in Batu City. The selection of the MSEs was based on the saturated sampling techniques with a consideration of less than 100 respondents. Therefore the population is the sample it self (20 people). The number of sample meets the criteria of small sample in GSCA with less than 30.

The instrument of the research is a questionnaire containing a number of questions on indicators and variables as shown in Table 1.

Mathematical model formulation: GSCA analysis of the reflexive models (variable X1) and formative models (variable X2, X3, Y1 and Y2) were grouped into outer and inner model.

Outer model:

- Variables of The Exogenous Latent 1 (reflexive):

$$X1.1 = \lambda x1.1.\ X1+\delta1 \quad (1)$$

$$X1.2 = \lambda x1.2.\ X1+\delta2 \quad (2)$$

$$X1.3 = \lambda x1.3.X1+\delta3 \quad (3)$$

- Variables of The Exogenous Latent 2 (formative):

$$X2 = \lambda x2.1.\ X2.1 + \lambda x2.2.\ X2.2+\delta5 \quad (4)$$

- Variables of The Exogenous Latent 3 (formative):

$$X3 = \lambda x3.1.\ X3.1 + \lambda x3.2.\ X3.2+\delta6 \quad (5)$$

- Variables of The Endogenous Latent 1 (formative):

$$Y1= \lambda y1.1.\ Y1.1 + \lambda y1.2.\ Y1.2+\varepsilon1 \quad (6)$$

- Variables of The Endogenous Latent 2 (formative):

$$Y2 = \lambda y2.1.\ Y2.1+\lambda y2.2.\ Y2.2+\lambda y2.3.\ Y2.3+\lambda y2.4.\ Y2.4+\lambda y2.5.\ Y2.5+\varepsilon2 \quad (7)$$

Inner model:

$$Y1 = \gamma1.\ X1+\zeta1 \quad (8)$$

$$Y2 = \beta1.\ Y1+\gamma2.\ X1+\gamma3.\ X2+\zeta2 \quad (9)$$

In GSCA analysis, feasibility evaluation was conducted both in the measurement model and the structural model. In the measurement model, the validity and reliability of the research instruments were assesed using the value of Averages Variance Extracted (AVE). In the structural model the relationship between the latent variables were assesed using the value of FIT and AFIT. The contribution of each variable as a result of GSCA model in this study is comprehensive, thus can be used as a recommendation in the selection of variables and indicators to be controlled to achieve the standardized production process of apple beverages.

RESULTS AND DISCUSSION

To achieve the competitive advantage businesses needs to identify and development of market segmentation to optimally sell their products (Huntm and Dennis, 2004). The feasibility of the GSCA model was assessed using the value of FIT and AFIT. FIT shows the total variance of variables that can be explained by a specific model. All variables in the model developed, explained 35.7% of the variation in the quality of apple beverages, while 64.3% of the variation can be explained by other variables such as extraction, packaging. The AFIT value showed that

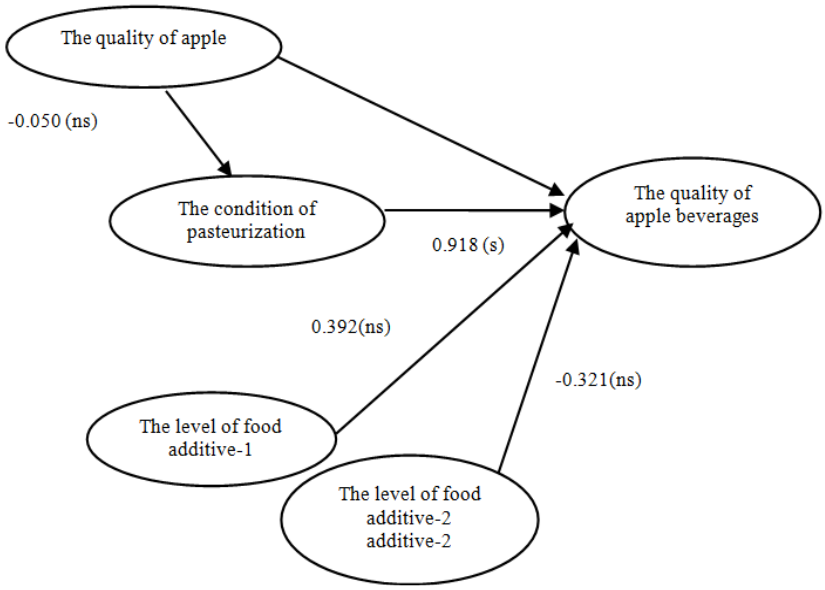

Fig. 1: The result of relationship between variables; s = significant; ns = non-significant

Table 2: The results ofanalysis in variables

	Path coefficients		
	Estimate	SE	CR
X1 ->Y1	-0.050	0.372	0.14 ns
X1 ->Y2	0.233	0.334	0.70 ns
X2 ->Y2	0.392	0.462	0.85 ns
X3 ->Y2	-0.321	0.480	0.67 ns
Y1 ->Y2	0.918	0.257	3.57*

*: Significant at the 5% level (p-value <0.05); ns: non-significant; SE: Standard Error; CR: Critical Ratio

quality of apple, the level of food additives, the condition of pasteurization and the quality of apple beverages which can be explained by the model was 30.5% and while (69.5%) can be explained by other variables. The results of the analysis of the influence and the relationships between variables using GSCA are shown in Fig. 1 and Table 2.

Mathematical model formulation: Shows the influence and direction of the relationship between the indicator variables and between latent variables in the model.

- The variables for the quality of apple:

$$X1.1 = 0.892\ X1 \quad (10)$$

$$X1.2 = 0.917\ X1 \quad (11)$$

$$X1.3 = 0.282\ X1 \quad (12)$$

The quality of apple had a negative and significant relationship with the condition of pasteurization with a value of -0.050 and SE 0.372 indicating the quality of the raw materials (apple) negatively but did non-significant effect the condition of the pasteurization. The quality of apple had a positive but insignificant relationship with the quality of apple beverages with a value of 0.233 and SE 0.334. Grade and total sugars are determinant variables of fruit quality for varieties of apples and are appropriate to assess the quality of apple beverages. Basically in the evaluation of the quality of the product, it is important to determine the chemical composition, sensory attributes and content of both substances in the raw materials and the products. The use of raw materials can vary in the level of maturity and variety of apple (Muntean and Nicoleta, 2010). Grade may indicate the level of maturity of fruit which is the process of physical, chemical and metabolic characterized by discoloration of the fruit, the fruit tissue softening and development of aroma and flavor of the fruit (Wills *et al*., 1997; Dixon and Errolw, 2000). Factors affecting the quality of the product depend on the food system assessment, process and environmental management (Huaxi and Qingbin, 2013).

- The Variables for the Level of Food Additives-1:

$$X2 = 0.036\ X2.1–0.999\ X2.2 \quad (13)$$

The level of food additives-1 (preservative and sweetener) have a non-significant positive relationship with the quality of apple beverages with a value of 0.392 and SE 0.462 showing that the levels of food additives-1 did non-significant effect the quality of products (apple beverages) with a unidirectional relationship. The use of food additives is considered for the maximum economic benefit as shown in the optimization of the use of additives to the amino acid content (Jianfeng *et al*., 2014). If the production of apple beverages showed that the addition of preservative levels inversely related to levels of sweetener, thus the more preservative added in the apple beverages the less theuse of the sweetener. Basically preservatives and sweeteners have the same function to improve the properties of function products and to extend the shelf life of the product.

- The Variables for The Level of Food Additives-2:

$$X3 = -0.646\ X3.1–0.652\ X3.2 \quad (14)$$

The level of Food Additives -2 have a non-significant negative relationship with the quality of apple beverages with a value of -0.321 and SE 0.480 indicated that the levels of food additive effect was non-significant on product quality (apple beverages) with the direction of the relationship is not unidirectional. The use of food additives can improve the quality of food and beverages products, on the other hand can negatively effect health. Adding acidity regulator in useful as a preservative in the same time increasing the sensation of flavour. On the use of sugar ranging from 10-12% equals to 0.05-0.3% acidity appearance to provide good flavor and shelf life.

- The Variables for the condition of pasteurization:

$$Y1 = -0.997\ Y1.1+0.530\ Y1.2 \quad (15)$$

$$Y1 = -0.050\ X1 \quad (16)$$

Thermal pasteurization treatment using a low temperature and a long duration was reported to have an impact on the reduction of the quality and freshness of the products (Rupasinghe and Li, 2014). The time and temperature required for a safe process depend on the destruction of microbial spores and enzymes inacitivation in the pasteurization process to minimize the damage of the quality of the products (Waghray *et al*., 2012).

- The Variables for The Quality of Apple Beverages:

$$Y2 = 0.233\ Y1 \quad (17)$$

$$Y2 = -0.992\ Y2.1+0.414\ Y2.2–0.251\ Y2.3+0.116\ Y2.4 +0.074\ Y2.5–0.062\ Y2.5 \quad (18)$$

$$Y2 = 0.918\ Y1+0.233\ X1+0.392\ X2–0.321\ X2 \quad (19)$$

The content of total dissolved solids and acidity will help to design the optimal strategy in the assessment of post-harvest fruit quality. Besides the taste and texture has a great influence on the evaluation of the quality of fruit juice (Oraguzie *et al*., 2009).

The condition of pasteurization had a positive and significant relationship with the quality of apple beverages as shown by the critical value was obtained at 95% confidence level. The results of the analysis on the model coefficient estimates indicated that the condition of pasteurization directly influenced the quality of apple beverages (value of 0.918 with SE 0.257). This indicates that the better the condition of pasteurization, the better the quality of apple beverages.

Pasteurization is a process of preserving a drink by thermal and non-thermal combined with the use of food additives to extend the shelf life of the product in which the higher the temperature and the longer the time the more the reduction of the quality of the resulting products (Rupasinghe and Li, 2014). Optimum pasteurization can minimize damage to the quality of the resulting product, during the process loss a little amount of aroma and flavor due to the evaporation process. However, a decrement in aroma and flavor can be anticipated with the addition of flavor and taste enhancer in the form of acid and flavor enhancers. This was supported by the findings from (Rattanathanalerk *et al*., 2005; Cañumir *et al*., 2002) showing that the pasteurization process also resulted in a decrease in fruit quality such as loss level of vitamin C, total acidity (acid) and total dissolved solids in ºBrix. Products with a high acidity (pH range between 3-4) should avoid heating with a high temperature because it decrease the nutritional value of the product, as well as the flavor of the beverages (Ashurst, 1998), thus the use of optimum temperature is suggested (Fellows, 2000; Torkamani, 2011), Pasteurization is an important step in the production of fruit juice to produce a better taste and to extend the shelf life therefore more acceptable and safety for consumers.

The novelty of this study that the quality of apple, the level of food additives, the condition of pasteurization and the qualty of apple beverages can expresion in the matematic model with GSCA analysis, the know about effect and corelation fr significant at the 5% level.

The limitation of this study is the low value of the feasibility of the model which is only 35.7%, other variables which were not observed, explained 64.3%. Other variables in the production of apple beverages which were not include in model such as extraction, sortation that were critical for the production. The previous research on critical points in the production of fruit juice reported that raw material sortation washing, filtration, sterilization and packaging (Widaningrum and Winarti, 2007), sterilization bottles and cups, pasteurization and products storage (Mulyawanti and Kun, 2010), food additives, pasteurization and bottling (Santoso, 2005) are important variables. Further research assesing these variables may be useful to predict the quality of apple beverages.

CONCLUSION

It can be concluded from this study for apple beverages of production in MSEs that the condition of pasteurization is significant effect the quality of apple beverages at significant at the 5% level. The quality of apple and the level of food additive had no significant effect on the quality of apple beverages. The formulation model in the production system of apple beverages in MSEs is:

$$Y2 = 0.918\ Y1+0.233\ X1+0.392\ X2–0.321\ X3.$$

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