

# PROCESS ENGINEERING OF DRYING MILK POWDER WITH FOAM MAT DRYING METHOD,

## A Study of the Effect of the Concentration and Types of Filler

Arie Febrianto\*, Sri Kumalaningsih, Ariesta Windi Aswari

Faculty of Agriculture, University of Brawijaya, Malang of Indonesia

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### ABSTRACT

The purpose of this study was to determine the best treatment combination between the concentration and type of filler to produce milk powder with the best physical and chemical properties which made with foam mat drying method. Materials used in the manufacture of powdered milk are fresh milk. Filler used are maltodextrin and Arabic gum, whereas emulsifier used was Tween 80. The method used is an experimental study with experimental design using a pattern of nested randomized block design with two treatment factors, they are the type and concentration of filler used. On the type of filler there are 2 levels of maltodextrin and Arabic gum. At a concentration of filler, there are 3 levels, for maltodextrin (10%, 15%, and 20% w/v fresh milk), while for the Arabic gum (3%, 6%, and 9% w / v fresh milk). The results showed for the filler concentration of 6% gum Arabic, and maltodextrin concentration of 15%. Furthermore, using the method of multiple attributes, we selected the best among these two types of filler. The best results obtained from the milk powder with the type of filler maltodextrin concentration of 15% with a yield value of 19.40%, 71.08% solubility, water content 3.73%, and 10.26% protein content.

**KEY WORDS:** drying, milk powder, concentration, filter, foam mat drying.

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### INTRODUCTION

Milk is one kind of food that is composed of nutrients with balanced proportions and can be viewed as sources of food that contains important nutrients. According to Buckle [1], the composition of fresh milk consists of water 87%, fat 3.9%, protein 3.4%, and lactose 4.8%, ash 0.7%, together with other ingredients such as enzymes, citrate, phospholipids, and vitamins. In addition to having excess, fresh milk has some weakness that is highly susceptible to contamination physical, chemical, or biological. Processing of fresh milk into milk powder is one way to obtain the added value of fresh milk and extend the shelf.

Filler material is a material that needs to be added in the processing of milk powder, especially in the drying process. The need for the addition of filler material due to the composition of water in fresh milk is very large, namely 87%. The amount of water content in fresh milk turn out to be a major problem in fresh milk drying process because the yield of milk powder produced will be very little. Therefore filler material used in the drying process of fresh milk into milk powder. According to Masters [2], the purpose of the addition of filler material in food processing is to coat the components of flavor, increase the amount of total solids, increase the volume, speed up the drying process and prevents the material damage caused by heat.

This type of filler material that is often used in the food industry is maltodextrin and Arabic gum. Maltodextrin is a concentrated solution of saccharides obtained from starch hydrolysis by the addition of acid or enzymes [3]. According to Klose and Glicksman [4], gum arabic is the result of secretion of the skin or the stems of plants of certain species of acacia tree in the form of viscous liquids and will become solid when cooled.

Mechanical drying foam (foam mat drying) is a way of drying materials that were previously liquid and then transformed as a liquid foam first [5]. This technique had advantage that a lower drying temperature, the use of foam that accelerates the evaporation of the water, low cost, and easy to do. Jagtiani [6] states that the temperature used in the methods of foam-mat drying is 50 -80 ° C. With a foam mat drying method expected drying time can be faster, cheaper, and easier when compared to the usual method of drying. The purpose of this study was to determine the best treatment combination between the concentration and type of filler material to produce milk powder with the physical and chemical properties of the best are made with foam mat drying method.

### MATERIALS AND METHODS

Materials used in the manufacture of powdered milk are fresh milk obtained from Ngaglik Village, Batu, and East Java Province of Indonesia. Excipients used are maltodextrin and gum arabic, whereas emulsifiers used was Tween 80. The materials used in testing milk powder is aquades, Kjeldahl tablets, concentrated H<sub>2</sub>SO<sub>4</sub>

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\*Corresponding Author: Arie Febrianto, Faculty of Agriculture, University of Brawijaya, Malang of Indonesia.  
Email: Ariefebrianto15@yahoo.com

solution, the indicator PP, 3% boric acid solution, the red metal indicator, 32% NaOH solution, and 0.1 N HCl solution.

This study uses experimental design of randomized block design with 2 factors nested patterns of treatment of each type and concentration of filler material used. The first factor is the type of filler which have two levels of maltodextrin and arabic gum. The second factor is the concentration of each filler, there are 3 levels is to use a concentration of 5% maltodextrin, 10%, and 15% w / v of fresh milk, while for the gum arabic concentration used 2%, 4%, and 6% w / v of fresh milk and each level is repeated for 3 times.

The process of making milk powder from fresh milk is to measure the amount of fresh milk to be used as much as 200 ml for each sample using a measuring cup. Fresh milk is then cooled until the temperature 0o C which is the optimum temperature for pretreatment. Fresh milk has reached a temperature of 0o C and then mixed with an emulsifier Tween 80 1% v / v of fresh milk (2 ml) in plastic and glass containers in homogenasi using a mixer at speed 1 and then increased kekecepatan 2 and 3 are begantian for 3 minutes. Fresh milk which has been mixed with an emulsifier added to the filler material according to design experiments that have been re-established and stirred using a mixer at speed 1 and then increased speed 2 and 3 alternately for 5 Fresh milk which has been mixed with emulsifiers and the filler material is then poured on a stainless steel pan size 25 x 30 cm which has been coated with plastic. Milk on a baking sheet thickness  $\pm$  2 mm. Pan of milk included in the vacuum dryer and dried at a temperature of 70° C. Drying milk lasts for 7 hours with a pan on a rack position shift every 2 hours. Milk that has been dried and then removed from the vacuum dryer and blender. Milk powder that has been blended sieved using 80 mesh sieve to obtain milk powder with a uniform size.

Data analyzed from the results of this study include the yield, solubility, water content, and protein levels. Data obtained from the results of research in the laboratory, then analyzed by ANOVA which will produce variants of each factor. F test is then performed to determine the truth of the hypothesis by comparing the calculated F values with F tables. If the obtained results are significantly different treatment then continued with the Smallest Real Difference test (LSD) test with a level of 0.05. Selection of best alternative is based on analysis performed using the Multiple Attribute.

## RESULTS AND DISCUSSION

### *Product Yield*

In the results obtained by treatment of the average yield of milk powders ranged from 10.32% to 19.40%. Arabic gum on the type of filler lowest yield 10.32% and 12.47% highest yield. On the type of filler maltodextrin lowest yield 12.56% 19.40% highest yield. The lowest yield values obtained from the treatment of type filler concentration of 2% Arabic gum that is equal to 10.32%, while the highest yield obtained from the treatment of type filler maltodextrin concentration of 15% that is equal to 19.40%. Yield value of milk powder with no added fillers is 7.75%. Value of the resulting product yield is greater when compared with the yield value of milk powder with no added fillers.

**Table 1 Average Yield of Milk Powder made form Foam Mat Drying Method**

Filler Type	Filler Concentrate	Yield Average (%)	Notation	BNT 5%
Arabic Gum	2%	10.323	A	0,952
	4%	11.542	B	
	6%	12.467	Bc	
Malto-dekstrin	5%	12.562	A	
	10%	17.325	B	
	15%	19.402	C	

On the treatment differences in each type of filler concentration obtained average solubility of milk In the analysis of different types of filler notation in Table 1 indicate a significant difference in the effect of filler concentration on the yield of milk powder.

Table 1 show that there is a rise in the yield of milk powder on the addition of filler concentration. The higher the concentration of filler is added, the greater the yield of milk powder produced. This is because the filler itself serves to increase the amount of total solids and increase the volume of the dried material. This is in accordance with the Master [2], that the addition of filler material in food processing aims to coat components of flavor, increase the amount of total solids, increase the volume, speed up the drying process and prevents the material damage caused by heat.

### **Solubility**

In the treatment differences in each type of filler concentration obtained an average solubility of milk powder range from 50.30% to 71.08%. While on Arabic gum filler solubility range between 50.30% (lowest solubility) and 56.68% (highest solubility). On the type of filler maltodextrin solubility range from 53.89%

(lowest solubility) to 71.08% (highest solubility). The lowest solubility values obtained from the treatment of type filler concentration of 2% Arabic Gum that is equal to 50.30%, while the highest solubility is obtained from the treatment of type filler maltodextrin concentration of 15% that is equal to 71.08%.

**Table 2 Average Solubility of Milk Powder Made From Foam Mat Drying Method**

Filler type	Filler Concent rate	Average Yield (%)	Notation	BNT 5%
Arabic Gum	2%	50,297	A	2,297
	4%	53,225	B	
	6%	56,684	C	
Malto-dekstrin	5%	53,891	A	
	10%	62,065	B	
	15%	71,083	C	

In Table 2 different notations indicate a significant difference in the effect of filler concentration on solubility of milk powder.

Table 2 shows that there is an increase solubility of of milk powder on the addition of filler concentration. Filler contains alot of hydroxy group that can form hydrogen bonds with water so that the higher the concentration of filler is added, the greater the solubility of milk powder produced. On filler Arabic gum contains increased solubility of milk powder, but the increase in it's solubility is smaller when compared with maltodextrin. This is caused by the difference in the concentration of Arabic gum filler added is smaller.

Filler maltodextrin have the increased solubility of milk powder to a significant level. According Sakarosa [7], maltodextrin has a solubility of 98.32%. Maltodextrin has specific properties of high solubility [6,8]. According to Argo [9], while on Arabic gum itself has a solubility of of 50%. Arabic gum has a group which is non polar, so the solubility is lower than maltodextrin.

**Water Content**

The average of water content of milk powder on the outcome of treatment differences in each type of filler concentrations ranged from 3.73% to 5.97%. On Arabic gum filler, lowest water content 4.02% and the highest water content 5.97%. While on filler maltodextrin its lowest water content is 3.73% and the highest water conten 5.86%. The lowest water content values obtained from the treatment of type filler maltodextrin concentration of 15% that is equal to 3.73%, whereas the highest water content obtained from the treatment of Arabic gum type filler concentration of 2%, that is equal to 5.97%. The average value of the water content of products is still small compared to water content of milk powder made without emulsifier and filler, that is equal to 7,095%

In Table 3 it can be seen that the value of the average water content of milk powder and the calculated data. The concentration of Arabic gum filler 2% and 4% had significant differences, while at a concentration of 4% and 6% did not have significant differences, but at a concentration of 2% and 6% had a noticeable difference. Maltodextrin concentration of 5% and 10% has a real difference, 10% and 15% did not have significant differences, but at concentrations of 5% and 15% have a noticeable difference. Both types of filler provide a noticeable effect on the water content of milk powder.

**Table 3 The Average of Milk Powder Water Content Made from Foam Mat Drying Method**

Filler type	Filler Concent rate	Average Yield (%)	Notation	BNT 5%
Arabic Gum	2%	5,972	a	1,034
	4%	4,592	b	
	6%	4,017	bc	
Malto-dekstrin	5%	5,860	a	
	10%	4,685	b	
	15%	3,732	bc	

Table 3 shows that there is a decrease in water content of milk powder on the addition of filler concentration. The higher the concentration of filler is added, the smaller the water content of milk powder produced. The drying process will reduce the water content and lead concentration of the remaining ingredients, namely solids. The more solids that are on the dried material causing the percentage of water in these materials is reduced, so the easier it is to evaporate the water. In the analysis the type of filler can be seen that different filler concentrations on different types of filler, does not give significant effect on water content levels of milk powder made by the methods of foam mat drying.

### Protein Content

In the treatment differences in each type of filler concentration obtained average protein content in milk powder ranged from 10.26% to 20.77%. While on Arabic gum filler lowest protein content 15.82% and the highest protein content of 20.77%. On filler maltodextrin the lowest protein content of 10.26% and the highest protein content of 15.63%. The lowest protein content values obtained from the treatment of type filler maltodextrin concentration of 15% is equal to 10.26%, while the highest protein content obtained from the treatment of Arabic gum type filler concentration of 2%, is equal to 20.77%. Protein content of milk powder made without fillers and emulsifiers amounted to 27.03%. Decreased levels of protein milk powder made by the methods of foam mat drying due to too much filler material used in the process.

**Table 4 Average Protein Content of Milk Powder made From Foam Mat Drying Method**

Filler type	Filler Concent rate	Average Protein Content (%)	Notation	BNT 5%
Arabic Gum	2%	20,765	a	1,518
	4%	17,790	B	
	6%	15,817	c	
Malto-dekstrin	5%	15,626	a	
	10%	12,398	B	
	15%	10,257	c	

In Table 4 different notations indicate a significant effect of differences in the type and concentration of filler on the protein content of milk powder.

Table 4 shows that there is a decrease in protein content of milk powder on the addition of filler concentration. The higher the concentration of filler is added, the smaller the protein content of milk powder produced. This is due to the additional material that reduces the percentage of protein in the material.

### The Selection of Best Treatment

While on Arabic gum filler, the best treatment results are shown While on Arabic gum with a concentration of 6% of value yield 12.56%, 56.68% solubility, water content 4.02%, and 15.82% protein content. Filler maltodextrin best treatment results are shown in the treatment with a concentration of 15% maltodextrin which has a yield of 19.40%, 71.08% solubility, water content 3.73%, and 10.26% protein content.

Furthermore, with the same multiple attribute methods, we choose one of the two alternatives types of filler. The best results obtained from the milk powder with the type of filler maltodextrin with a concentration of 15%. In this treatment we obtained yield values 19.40%, 71.08% solubility; water content 3.73%, and 10.26% protein content.

### CONCLUSION

The type and concentration of filler material Arabic gum and Maltodextrin have real impact on yield, solubility, water content, and protein levels in milk powder made by foam mat drying methods. The best results were obtained in treatment with the type of filler material maltodextrin, with a concentration of 15%. Milk powder with the type of filler maltodextrin concentration of 15%, obtaining yield value 19.40%, 71.08% solubility, water content 3.73%, and 10.26% protein content.

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