ISBN : 978-602-14917-9-9

WAFER FEED CONTAINING BY PRODUCT OF HABBATUSSAUDA (*NIGELLASATIVA*) OPTIMIZATION PROCCES WITH MOLASESS VISCOSITY APPROACH

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Abstract. Habbatussauda by product in the form of wafers is a good inconventional feed for sheep because efificient on consumtion that is not easily scattered when consume and eficient in the storage feed management.Optimization Process needed to get the best quality of wafers. Molasses known as the binder for wafers. Viscosity and sugar content of molasses are important factors for the success of wafers forming. The aim of this study was to optimize the process of habbatussauda Wafers producingg on molasses viscosity to the optimal manufacturing time and good physical quality of wafers.This study used 4 replications per treatment. The experimental design that was carried out was a completely randomized design (CRD) with two factors (heating time 5%, 10%, 15% and molasess viscosity 120%, 140% and 150%). The longer heating time proces had a very significant decrease ($P<0.01$) on mositure, water activity, and increase durability of wafer containing*Nigella sativa meal*. had significant influence on ($P<0.01$) wafer durability with the oprimal level is medium viscosity. All factor not influence on the machine effisiency. The results showed that the optimal time to make wafers is 10-15 minutes with a viscosity level of molasses is 140%.

1.INTRODUCTION

Habbatussauda (Nigella sativa) is included into Ranunculaceae family that is famous as herbal plant.

Habbatussauda contains 22.7% crude protein, 35.5% crude fat, 0.5% -1.6% volatile oil, and 35.6% - 41.6% fixed oil [1]. Habbatussauda contains high oil content with active pharmacological substances, so that it will be processed for medicinal purposes. Habbatussauda oil processing industry produces waste in the form of residue from habbatussauda oil extraction. Use of habbatussauda in large and medium industries in Indonesia reached 144 817 kg year^{-1} [2]. From these uses, the potential for habbatussauda waste produced is as much as 101 372 kg year^{-1} or as much as 70% of the total raw material [3]. Habbatusauda waste from cold press method contains a moisture content of 8.1%, crude protein 23.3%, and ash 9.6% [4]. Habbatusauda waste also contains several minerals such as Mg, Fe, Cu, Ca, and K [5].

By-products of agricultural products in Indonesia have good potential for livestock, especially ruminants. These byproducts can often be used as feed ingredients. By-products of agricultural products still have high levels of nutrients. The problem with raw materials for making ruminant feed from agricultural waste is that it has voluminous properties. In Indonesia, Molasses processing sugar cane results are known as cane drops. Molasses contains large amounts of sucrose, glucose, fructose and raffinose and several non-sugar organic matter [6]. Molasses has high

ISBN : 978-602-14917-9-9

mineral calcium (Ca), um (K), magnesium (Mg), sodium (Na), chlorine (Cl), and sulfur (S) but very low phosphorus (P) and crude protein [7]. Some technology has been carried out to deal with the voluminous nature of agricultural waste feed ingredients, one of which is the formation of feed wafer. Feed wafer is a physical and mechanical feed processing technology with the principle of pressing or condensing a mixture of materials with high
temperature in a short time so as to produce a solid and square-shaped product. The square shape will facilitate the storage of materials and will improve transportation efficiency because there is no more empty space as a gap betweenmaterials. Molasses that circulate in Indonesia has very diverse qualities and prices. The quality of molasses can be determined by the high level of viscosity. Molasses that have high viscosity are considered to have high glucose levels. Glucose level influences the quality of the wafer that will be produced primarily in the process of gelatinization and heating in order to produce a sweet aroma that livestock like.
In the implementation of production, human, machine and material resources must be interpreted as limited resources, it is common for organizations not to consider the limited resources they have when preparing a production plan. The quality of the wafer is determined by the constituent material, especially the binding material, namely molasses, the heating time required the best combination to produce physical and chemical quality wafers, but by optimizing the resources it is not impossible that maximum benefits can be obtained. Then an optimization is performed to get the best results under the given cir cumstances. The ultimate goal of all these activities is to minimize the effortor maximize the desired benefits. Because the required effort or desired benefits can be expressed as a function of the decision variable, optimization can be defined as the process of finding conditions that give a minimum or maximum value of physical, chemical and storing quality of the wafer produced. The purpose of this study was to optimize the process of producing habbatussauda wafers by using a molasses viscosity level on the optimal manufacturing time to produce good quality feed wafers.

2. MATERIALS AND METHODS

2.1 Time and Location

This research was conducted in September 2019 - Oktober 2019. The research location was the Laboratory of Animal Feed Industry Field, Faculty of Animal Science, IPB University to conduct wafer production, phyisical quality testing of wafers and machine efficiency.

2.2 Material

The tools used in this study were wafer machines, digital scales, durability index testing instruments, grinders and aw meters. The material used in this study is the ingredients of feed for ruminant rations and molasses.

ISBN : 978-602-14917-9-9

Table 1. Compotition and nutrient content as dry matter base on

Feed	%
Habbatussauda Waste	28
Pollard	35.0
Onggok	31.5
Molases	4.0
CaCo3	1.0
Premix	0.5
Total	100
Nutrient	%
Dry Matter	86.72
Ash	5.54
Crude Protein	15.59
Ether Extract	2.97
Crude Fiber	7.11
Nitrogen Free Extract	67.28

Source : Barkah 2018

2.3 Procedure

2.3.1 Wafer production

The procedure for making complete ration wafers from molasses for each treatment is as follows: (a) all feed raw materials were ground using a hammer mill machine to a mash size, (b) then all feed raw materials were mixed with molasses adhesive until homogeneous, until they become rations complete, (c) the complete rations was put into a 20 cm x 20 cm x 5 cm square wafer mold. After that, hot pressing was carried out at a temperature of 95-150 ^oC with heating time 5, 10, and 15 minutes and a pressure of 200-300 kg / cm^2, (d) then cooling the wafer sheet was performed by placing the wafer in the open air for at least 24 hours until the water content and weight are constant.

2.3.2 Optimation Measurement

2.3.2.1 Machine efficiency

Machine efficiency can be obtainedfromused raw material in making wafers and amount of raw material to produce a finished product. Efficiency can be shown by calculation as follows:

$$\text{Efficiency} = \frac{\text{Actual Output}}{\text{Effective Capacity}}$$

Barry Render dan Jay Heizer (2007)

2.3.2.2 Moisture

Moisture content was measured by using a rika moisture meter. The sample was blended with a blender then the sample was inserted into the tool. Read the scale of the water content in the instrument.

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2.3.2.3 Water Activity

Water activity was obtained from the measurement of wafers measuring 5 x 5 x 1 cm using Aw meters for one hour of observation that had previously been calibrated by using a solution of Barium Chloride ($BaCl_2$). The solution was left for three hours after the Aw meter needle was pulled until it showed 0.9 because $BaCl_2$ had saturated salt humidity of 90%. The value of water activity is calculated by the formula:

Aw = Scale ± {|temperature -20|x 0.002}

2.3.2.4 Wafer Durability Index (WDI)

Wafer Durability Index (WDI) test used the Pellet Durability Index (PDI) method according to [8] by using a box equipped with a rotator that was rotated for 10 minutes at a speed of 50 rpm, then the ratio between the weight of the wafer after it had been rotated was calculated to the weight of the whole wafer before it had been rotated.

2.4 Experimental Design

The experimental design was carried with a completely randomized factorial (3x3). Wafers with a temperature of 105 ºC, the first factor was the heating time of 5 minutes, 10 minutes and 15 minutes, and the second factor was the viscosity of molasses with a viscosity level of 125% + 48% sugar content, viscosity level of 140% + 50% sugar content and viscosity level of 150% + 55% sugar content. This study used 4 replications per treatment. The treatment carried out in this study were:

T1V1 : Temperature 105 ºC, time 5 minute, dan molasess viscosity of 125% (glucose 48%)

T1V2 : Temperature 105 ºC, time 5 minute, dan molasess viscosity of 140% (glucose 50%) T1V3 : Temperature 105 ºC, time 5 minute, dan molasess viscosity of 150% (glucose 55%) T2V1 : Temperature 105 ºC, time 10 minute, dan molasess viscosity of 125% (glucose 48%) T2V2 : Temperature 105 ºC, time 10 minute, dan molasess viscosity of 140% (glucose 50%) T2V3 : Temperature 105 ºC, time 10 minute, dan molasess viscosity of 150% (glucose 55%) T3V1 : Temperature 105 ºC, time 15 minute, dan molasess viscosity of 125% (glucose 48%) T3V2 : Temperature 105 ºC, time 15 minute, dan molasess viscosity of 140% (glucose 50%) T3V3 : Temperature 105 ºC, time 15 minute,dan molasess viscosity of 150% (glucose 55%)

2.4.1 Data Analysis

The data obtained were analyzed by using analysis of variance (ANOVA). If the data had significantly different results then duncan Test performed. The mathematical model used is based on [9].

$$\mathbf{Yij = \mu + \alpha + \beta + \alpha\beta + \varepsilon}$$

Yij : The value of the observation

μ : General mean

α : effect of heating timetreatment

β i j : effect of molasess viscosity treatment

αβ : interaction of treatment

εij : error of treatment ij

3. RESULT AND DISCUSSION

3.1 Wafer Quality

The heating time had a very significant influence ($P<0.01$) on mositure, water activity, and durability of wafer on *Nigella sativa meal*. Molasess viscosity levels had no effect on mositure and water activity but had significant influence on ($P<0.01$) wafer durability. There was no interaction between the heating time and the water viscosity level on the mositure, water activity and wafer durability. Data of the effect of heating time and the level of molasses viscosity on the wafer quality presented in table 2.

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Table 2. The effect of heating time and the level of molasses viscosity on physical wafer quality

Variabel	Viscosity / time (minute)	5	10	15	Average
Moisture (%)	Low	11.88 ± 0.78	11.35 ± 0.93	9.95 ± 0.53	11.05 ± 1.09
	Medium	11.23 ± 0.49	11.4 ± 0.96	10.35 ± 0.17	10.99 ± 0.72
	High	11.65 ± 1.45	10.83 ± 0.52	9.45 ± 0.40	10.64±1.26
	Average	11.58 ± 0.94^{B}	11.19 ± 0.79^{B}	9.91 ± 0.53^{A}	
WA^{a}	Low	0.68 ± 0.09	0.62 ± 0.04	0.58 ± 0.02	0.63 ± 0.07
	Medium	0.65 ± 0.03	0.61 ± 0.02	0.59 ± 0.02	0.61 ± 0.04
	High	0.63 ± 0.02	0.60 ± 0.02	0.58 ± 0.03	0.61 ± 0.02
	Average	0.66 ± 0.05^{B}	0.61 ± 0.02^{A}	0.58 ± 0.02^{A}	
WDI^{b} (%)	Low	51.35 ± 14.46	58.87 ± 0.78	61.17 ±10.19	57.13 ± 10.2^{B}
	Medium	62.12 ± 4.96	67.68 ± 2.67	71.70 ± 6.11	67.16 ± 7.02^{C}
	High	39.43 ± 8.62	48.98 ± 5.51	55.71 ± 2.42	48.04 ± 8.87^{A}
	Average	50.97 ± 13.33^{A}	58.51 ± 8.61^{B}	62.85 ±9.36^{B}	

[a)]Wa=water activity,
[b)]WDI= Wafer Durability Index, low = molasses viscosity of 120%, medium= molasess viscosity of 140%, high = molasess viscosity of 150%.
Supercript in the same line and column describes statistic significantly level (P<0.01)

The lowest moisture was present in the 15-minutes heating time treatment. Heating influences the water content and water activity because during the heating process the water will evaporate so that the water content in the material will be reduced. Moisture content determines the quality of the wafer feed. The higher the water content of a material will accelerate the damage of a feed ingredient. According to [10] the wafer water content of feed was 14%. The results of this study had lower levels of moisure than [10] study, this is due to the different wafer ingredients used. According to SNI (1996) the maximum moisture contained in feed ingredients is 16%. The quality of wafers in this study is quite good because it has a moisture content below 16% according to SNI recommendations (1996).

Moisture is related to the level of water activity. Water is a good growing medium for microbes. Water activity indicates the microbial activity in a material. The higher the value of water activity, the faster the damage of a feed material. The best treatment in this study is heating time of 10-15 minutes because it had lower water activty than the heating time of 5 minutes. In the 5-minutes heating process the moisture contained in a material is still high so that the microbial activity is still high compared to the 10-15- minutes heating time.

Wafer durability index (WDI) is an indicator of the success wafer production. WDI shows thepercentage of wafer strength against impact. The quality of wafer durability is measured by wafer quality during transportation. Durability or resistance to impact testing is carried out to determine which feed ingredients can withstand impact, friction, and fall during the storage and distribution process [11]. If the wafer is easily destroyed means the quality is not good because the manufacturing process is less than optimal. The best treatment of this research is the heating time of 10-15 minutes and the moderate viscosity level is 140%. During the 5 minutes heating process, the wafer is easily destroyed by its low percent durability. The process of heating that is too short causes the gelatinization process of molasses as a wafer adhesive with high glucose levels has not occurred optimally so that the wafers have not formed completely. Medium viscosity is the best viscosity in making wafers

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for 10-15 minutes. This is thought to occur because in the viscosity the gelatinization process is running optimally. At low viscosity levels, a perfect gelatinization process has not yet occurred because the glucose level is too low, whereas at high viscosity gelatinization is not optimal because of the temperature used is not high enough or the heating time is not long. Other factors that affect durability according to are (1) the characteristics of raw materials, textures, and water, as well as the stability of material characteristics and (2) particle size [12].

3.2Machine Efficiency

Machine efficiency is measured to find out the percentage of product successfully formed by the wafer machine. The data showed that the heating time and molasess viscosity level had no significantly influence on machine efficiency. Data of the influence of heating time and molasess viscosity level on the machine efficiency is present in table 3.

Table 3. The effect of heating time and molasess viscosity level on the efficiency machine

Variable	Viscosity / Time (minute)	5	10	15	Average
Machine Eficiency (%)	Low	93.98 ± 0.8	94.32 ± 0.52	94.27 ±0.86	94.18 ± 0.69
	Medium	94.66 ± 0.72	94.92 ± 0.299	94.54 ±0.98	94.71 ± 0.71
	High	94.53 ± 0.03	94.35 ± 0.34	94.58 ±0.88	94.49 ± 0.51
	Average	94.39 ± 0.64	94.53 ± 0.46	94.46 ±0.84	

low = molasses viscosity 120%,
medium= molasess viskosity 140%, high = molasess viskosity 150%.

The duration of heating time and the level of viscosity of molasses did not significantly affect the machine efficiency because it was assumed that the temperature used was the same and the composition of the wafers used was also the same. In the process of wafers production, almost all of the material formed into wafers, it's just that the quality of the wafers is different. Wafers produced in 5 minutes are more crumb than those produced in 10 or 15 minutes as presented in the table 2. Viscosity had more influence on the physical quality of the wafer than on the efficiency of the wafer-making machine. In moderate viscosity it has better wafer quality compared to those with low and high viscosity, this is allegedly due to the effect of optimization of the gelatinization process on molasses that have high glucose levels.

4. CONCLUSION

The 10-15 minutes heating time is the best heating time in the wafer making process. Medium viscosity of molasses is the best viscosity in the process of making wafers. There was no interaction between the heating time and the viscosity of molasses on the quality of the wafer and the efficiency of the wafer making machine.

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