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Producing Quality Bokashi Compost, Development of Certified Chili Seedlings, and Processing Flavored Milk

Sigit Sudjatmiko[1]*, Dwi Wahyuni Ganefianti[1], and Endang Sulistyowati[2]

Crop Production Department, Faculty of Agriculture, University of Bengkulu, Indonesia
Animal Science Department, Faculty of Agriculture, University of Bengkulu, Indonesia
***Corresponding author: sigitsudjatmiko@unib.ac.id**
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ABSTRACT: The program aimed to produce high-quality bokashi compost, develop certified chilli seeds, and process cow's milk into flavored milk products. The results demonstrated that combining raw materials from the farmyard with dairy farm yard produced bokashi compost with favorable nutrient content: total nitrogen at 1.3%, phosphorus at 0.99%, potassium at 1.3%, organic carbon at 26.12%, and a C/N ratio of 17.18 qualified the standards of SNI 19-7030-200. Additionally, a comparison of 4 chilli hybrids with a combination revealed that the hybrid combination between UNIB C H63 x UNIB C H43 in the one plot achieved greater plant height and canopy area. However, although differences in yield components were not statistically significant, the single cropping of hybrids UNIB C H13 and UNIB C H53 significantly improved the resistance to yellow leaf curl disease. Lastly, the flavoured milk development resulted in a high-quality product with a fat content of 3.91%, protein at 3.30%, lactose at 4.96%, and a specific gravity of 1.032. Overall, the program successfully met its objectives, producing quality compost, promising chilli hybrids, and nutritious flavored milk.

Keywords: Sustainable agriculture, compost quality, certified chilli seeds, flavored milk

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INTRODUCTION

Kabawetan subdistrict, Kepahiang district, Bengkulu, is a centre for dairy farming. This location is 1000-1200 m above sea level with a temperature of around 18-26°C. This condition is a comfortable place for dairy cows to live, fulfilling the thermoneutral zone. Apart from that, this location is also a centre for vegetable crops, including chillies. Curly chilli varieties certified by the Ministry of Agriculture, due to research from the University of Bengkulu, need to be introduced in this area. The national chili production in 2021 is 1,360.570 tons, while consumption was 596,140 tons (BPS, 2022).

Meanwhile, dairy farms in this area generally do not implement concentrate feeding, so cow milk production is relatively low (5-8 l/cow/day) (Jarmuji et al., 2018). Dairy farm waste can also be used as compost. However, integration between dairy farming and horticultural crops such as chillies could be a source of economic drive in this area. The integration of these two agricultural activities synergizes by providing local concentrates to dairy cows other than those that produce milk. Apart from that, it also produces faeces, which can be processed into compost, which can be used as organic fertilizer for vegetable plants, such as curly chillies. The manure from dairy farms remains an environmental issue that local inhabitants, who are impacted, frequently voice concerns about (Rakhmat et al, 2024). The volume of cow dung generated significantly contributes to environmental pollution, yet cattle ranchers lack the appropriate equipment to convert it into high-value organic fertilizer products. Technological improvements are required for dairy farmers to convert cow manure waste into high-value compost fertilizer, hence enhancing family income.

Vegetable farming collectives significantly contribute to the sustenance of the village economy. Nonetheless, the technology employed in vegetable cultivation, including chilli plants, predominantly relies on traditional methods, such as the application of inorganic fertilizers with often uncontrolled dosages, excessive chemical pesticides, and the utilization of heirloom seeds produced by farmers in the Sukasari village region. Consequently, the productivity of the cultivated commodities is either stable or diminishing. Chili pepper seedlings cultivated by farmers are increasingly afflicted with yellow curly leaf disease, which Begomovirus causes. The provision of affordable quality seedlings to farmers is crucial for restoring land productivity and commodity yields. The lack of inorganic fertilizers and their rising prices complicate chili cultivation for farmers; so, supplying quality seeds and self-produced organic fertilizers will significantly enhance effective chili farming.

Curly chilies or *Capsicum annum* are the most widely cultivated and crossed. From the results of the research carried out, several varieties have been produced that have received PVP certificates from the Ministry of Agriculture, namely UNIB C H13 (341/PVHP/2015), UNIB C 23 (340/PVHP/2015), Dwiguna UNIB (339/PVHP/2015), UNIB C H73 (342/PVHP/2015) (Ganefianti et al., 2019). These varieties show resistance to Begomovirus disease (yellow leaf curl) and produce around 10 tons per hectare.

Compost is made up of organic wastes that have decompoesed through the work of microorganisms. Cow dung is organic waste that could be used as compost. Cow dung has nutrients such as 0.26% calcium, 0.11% phosphorus, 0.13% potassium, and 0.33% nitrogen. Instead of synthetic or fake fertilizer, compost is the best and most natural way to improve the soil. Most of the time, organic fertilizers don't have a lot of macronutrients like N, P, and K. However, they do have enough micronutrients, which plants, including chiles, need to grow. Because of this, it was very important to use these technologies, like hybrid red chili, Curmiyeast concentrate, and compost from dairy farms.

MATERIALS AND METHODS

Preparation of Bokashi compost based on dairy farm waste

The components are 1000 kg of cow manure, 250 kg of rice husks or green leaves, 3 litres of molasses, sufficient water to achieve moisture, and 3 litres of decomposer (EM4). A plastic cover for the compost mixture is positioned in a shaded area, protected from sunshine and rain. The composting process is divided into four phases. Phase 1 encompasses the mixing process, Phase 2 consists of a one-week-old mixture, Phase 3 comprises a two-week-old mixture, and Phase 4 includes the completed compost and its packing.

Compost material is composed of cow dung at the bottom, with leaves or straw layered on top. Distribute EM4 already activated with molasses uniformly. Adjust the humidity to 60%, ensuring that the material remains intact when held, but when it is insufficiently moist, add an adequate amount of water. The composite material is encased in plastic. The reversal occurs weekly. The composting process is assessed on the third day; if it is warm, composting is occurring. The composting process extends for three weeks. After three weeks, the compost is prepared, distinguished by the absence of heat and odor. Nutrient testing for nitrogen, phosphorus, potassium, and calcium was conducted.

The attributes of quality compost include a blackish-brown hue and a subtle perfume reminiscent of earth or forest humus, rather than a harsh odor. If grasped and squeezed, the compost will coalesce. When subjected to gentle pressure, the compost aggregates will disintegrate readily.

Growth and yield comparation of hybrid Red Chili

Four chili hybrids were cropped using single and mixed cropping including UNIB C H13, UNIB C H63, UNIB C H53,UNIB C H43, UNIB C H13 x UNIB C H63, UNIB C H13 x UNIB C H53, UNIB C H13 x UNIB C H43, UNIB C H63 x UNIB C H53, UNIB C H63 x UNIB C H43, and UNIB C H53 x UNIB C H43. Using a completely randomised block design, a 2 x 6 m2 plot with three replications was assigned. Cropping management was done in accordance with the chili standard, which included applying 200 kg/ha of urea, 200 kg/ha of SP36, and 100 kg/ha of KCl as fertilizer. With the exception of the day before irrigation when it rained, the plants were watered every day. When attacks exceeded the loss threshold limit, pests and diseases were managed as needed. The variables measured included Plant height, Canopy coverage, Stem diameter, Fruit number/plant, Fruit weight/plant, Fruit weight/plot, Salable fruit weight, and Yellow leaf curl.

Process of making flavored milk and Mango yoghurt

As for flavored milk procedure was started with addition of about 10 ml of strawberry or mocha paste, 10% of sugar into 1 liter of dairy cow milk, then was pasteurized in 70°C about 10 minutes. As for Mango yogurt, after pasteurization of original milk, 10% sugar, and 15% of mango concentrate, then cooled down into 40°C, inoculated with original yogurt containing *L. bulgaricus, L. acidophilus*, and *Bifidobacterium* for 15%, lid closed and kept in room temperature for 18 hours (Sulistyowati et al., 2016).

RESULTS AND DISCUSSION

Production of compost based on farm and dairy farm waste

Composting is most rapid when conditions that encourage the growth of the microorganisms are established and maintained. Organic materials appropriately mixed to provide the nutrients needed for microbial activity and growth, including a balanced supply of carbon and nitrogen (C/N ratio). Oxygen at levels that support aerobic organisms. Enough moisture to permit biological activity without hindering aeration. Temperatures that encourage vigorous microbial activity from thermophilic microorganisms.

The composting process that occurred as shown in the following Figure 1.

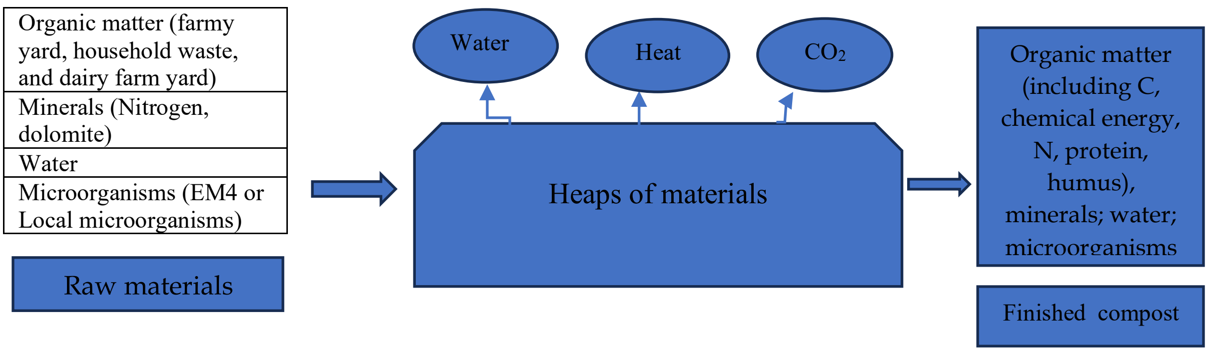

Figure 1. The diagram process of composting based on farm and dairy farm waste

The nutritional content of the Bokashi compost that has been made is presented in the table 1 as follows. The recommendation for composting is to have a ratio of C/N 16 containing dairy cow faeces and Kirinyuh leaves at a ratio of 1:1 (Safari et al., 2023).

The amounts of N in these results were lower than those found by Hidayat et al. (2023), but the P and K were higher. They found that the compost made of cow manure, rice straw, and marine organic garbage had a nitrogen content of 1.47 per cent, a phosphorus content of 0.38 per cent, and a potassium content of 0.2 per cent. The carbon to nitrogen ratio was 19.08. The different mineral amounts and C/N ratios in compost depend on the material used. The SNI 19-7030-2004 established the criteria for readily used compost that has a C/N ratio of 10 to 20. This meant that our C/N ratio (18.97) met the requirement.

Table 1. Nutrient contents of organic compost

Sample	N total (%)	P (%)	K (%)	C-organic (%)	Ratio C/N
Compost	1.3	0.99	1.3	26.12	17.18

Note: UNIB- Soil Science Laboratory (2024)

Only about about 29,7% of farmers know the basics of making compost, like what materials are used, what the function of EM4 is, how long to turn the pile of bokashi material is, how to mix the bio-activator solution into the pile of bokashi material, and how to use other materials, like straw, for bokashi compost material.

Comparison of chili hybrid cultivars

The results of the variance analysis of four hybrid chilli varieties planted with single and mixed cropping showed that all variables were not significantly different except plant height, canopy area, fruit diameter and yellow leaf curl disease (Table 2).

Table 2. Analysis of variance on growth and yield of four hybrid chilli varieties with single and combined planting patterns in the highlands

Variables	Fcount	CV (%)
Plant height	2.8 *	9.26
Canopy coverage	2.25 *	9.96
Stem diameter	2.12 ns	22.53
Fruit number/plant	1.5 ns	28.15
Fruit wegiht/plant	1.16 ns	15.89^{T}
Fruit weight/plot	1.16 ns	28.59
Salable fruit weight	1.55 ns	14.64
Yellow curly leaf	2.25 *	19.93

The growth of chilli

The results showed that the plant height and canopy area of four varieties planted singly or in combination differed significantly. Plant height ranged from 66.77 cm - 89.61cm, the highest was the combination of UNIB C H63 x UNIB C H43 but not substantially different from the UNIB C H63 (79.38 cm) and UNIB C H 43 (78.27 cm) varieties grown singly (Table 3).

The canopy area ranged from 2510.29 cm^2 to 4324.74 cm2; UNIB C H13 varieties planted singly had the widest canopy area of 4324.74 cm^2 compared to other varieties. From the average plant height data and canopy area, the varieties planted with single or combination planting patterns are not significantly different. This happens because each variety has different characters between one variety and another; each variety carries its genetic material.

Plant height in this study was positively correlated with canopy area (r=0.656) and stem diameter (r= 0.472) (Table 3). This means that the taller the chilli plants, the greater the canopy area and stem diameter, so it is expected to increase the yield of chilli. Plant height and plant canopy area determine the efficient planting distance in utilising sunlight for photosynthesis. Light is essential in photosynthesis; photosynthesis is key to plant metabolic processes.

Table 3. Plant growth comparison of different varieties of red chilli

Variety	Plant height (cm)	Canopy coverage (cm^2)	Stem diameter (mm)
UNIB C H13	76.05 ^{b}	4324.74 ^{a}	20.79
UNIB C H63	79.38 ^{ab}	2957.28 ^{ab}	17.56
UNIB C H53	66,77^{b}	3096.94 ^{ab}	16.33
UNIB C H43	78.27^{ab}	3530.58 ^{ab}	19.68
UNIB C H13 x UNIB C H63	67.5^{b}	2639.91 ^{b}	17.50
UNIB C H13 x UNIB C H53	72.55^{b}	2510.29 ^{b}	17.67
UNIB C H13 x UNIB C H43	76.11^{b}	3215.56 ^{ab}	20.77
UNIB C H63 x UNIB C H53	72.83^{b}	3126.92 ^{ab}	18.24
UNIB C H63 x UNIB C H43	89.61^{a}	4178.23 ^{a}	18.48
UNIB C H53 x UNIB C H43	70^{b}	2594 ^{b}	16.93

Large plant stem diameter can transport more nutrients and water, so the quantity of photosynthesis is improving, forming more flowers and fruits.

The yield of chilli

The number of fruits per plant, fruit weight per plant, fruit weight per plot, and marketable fruit weight were not significantly different in each treatment. In this study, the number of fruits per plant, fruit weight per plant, fruit weight per plot and marketable fruit weight ranged from 51 fruits-93 fruits, 167.47g - 345.73g, 2817.42g - 4815.82g and 1887.88g - 3921.95g respectively (Table 4).

Table 4. Yield comparison of different varieties of Red chilli

Variety	Fruit number/plant	Fruit weight /plant (g)	Fruit weight /plot (g)	Salable fruit weight (g)
UNIB C H13	93.55	345.73	4412.03	3305.23
UNIB C H63	71.38	242.08	4615.00	3921.95
UNIB C H53	67	305.28	4815.82	3890.94
UNIB C H43	54.66	220.22	3204.8	2488.31
UNIB C H13 x UNIB C H63	76.44	241.07	3330.96	2769.78
UNIB C H13 x UNIB C H53	69.00	287.34	4680.49	3261.40
UNIB C H13 x UNIB C H43	54.94	167.47	2817.42	1887.88
UNIB C H63 x UNIB C H53	68.27	297.20	4584.83	3549.57
UNIB C H63 x UNIB C H43	52.94	215.38	4298.95	3378.55
UNIB C H53 x UNIB C H43	51.05	255.29	3694.39	2704.15

The results of the correlation analysis between variables show that the weight of the fruit of the plant is positively correlated with the weight of the fruit plot at r = 0.718 and the weight of the marketable fruit at r = 0.668, meaning that the more the weight of the fruit of the plant, the more the weight of the fruit plot and the weight of the marketable fruit, in line with the opinion of Rofidah (2018) that the weight of the fruit plant positively correlates with the weight of the fruit plot. Plant fruit weight correlates with yellow leaf curl disease at r = -0.550.

Yellow leaf curl

Four chilli hybrids have been tested for resistance to yellow leaf curls (Ganfefianti et al., 2017). The disease attacked chilli plants throughout their life spans of the plants. In a recent study, the percentage of yellow leaf curl disease ranged from 37.5% - 69.43%. Varieties with a combination planting pattern had the highest rate, namely UNIB C H13 x UNIB C H43 at 69.43% (Table 5).

This percentage is more significant than the UNIB C H13 and UNIB C H43 varieties planted singly, with 48.63% and 50%. This shows that using a combination planting pattern in this study cannot suppress the attack of yellow curly leaf disease. In line with Jaya's research (2019), yellow curly leaf disease has the most significant percentage in the UNIB C H13 x UNIB C H53 variety at 16.67%, which is planted in combination.

Table 5. Average data of four hybrid chilli varieties with single and combination planting patterns on yellow leaf curl disease variables in the highlands

Varieties	Yellow leaf curl (%)
UNIB C H13	48.63^{b}
UNIB C H63	50.00^{ab}
UNIB C H53	37.50^{b}
UNIB C H43	50.00^{ab}
UNIB C H13 x UNIB C H63	59.70^{a}
UNIB C H13 x UNIB C H53	56.90^{a}
UNIB C H13 x UNIB C H43	69.43^{a}
UNIB C H63 x UNIB C H53	51.40^{ab}
UNIB C H63 x UNIB C H43	48.60^{ab}
UNIB C H53 x UNIB C H43	65.30^{a}

Infection of yellow curly leaf disease is caused by whitefly species insects (*Bemesia tabaci*) (Faizah et al. 2012). Control of yellow curly leaf disease other than using chemicals can be done by uprooting infested plants and clearing weeds in the research field. This is in line with the opinion of Thumury and Amanupunyo (2015) that the damage to chili plants caused by yellow curly leaf disease is caused by not sanitizing the affected plants and the large number of babadotan weeds (*Ageratum conyzides*) around the chili plants.

Production of flavoured milk and yoghurt

The production of processing fresh cow's milk into flavored milk goes through the following process.

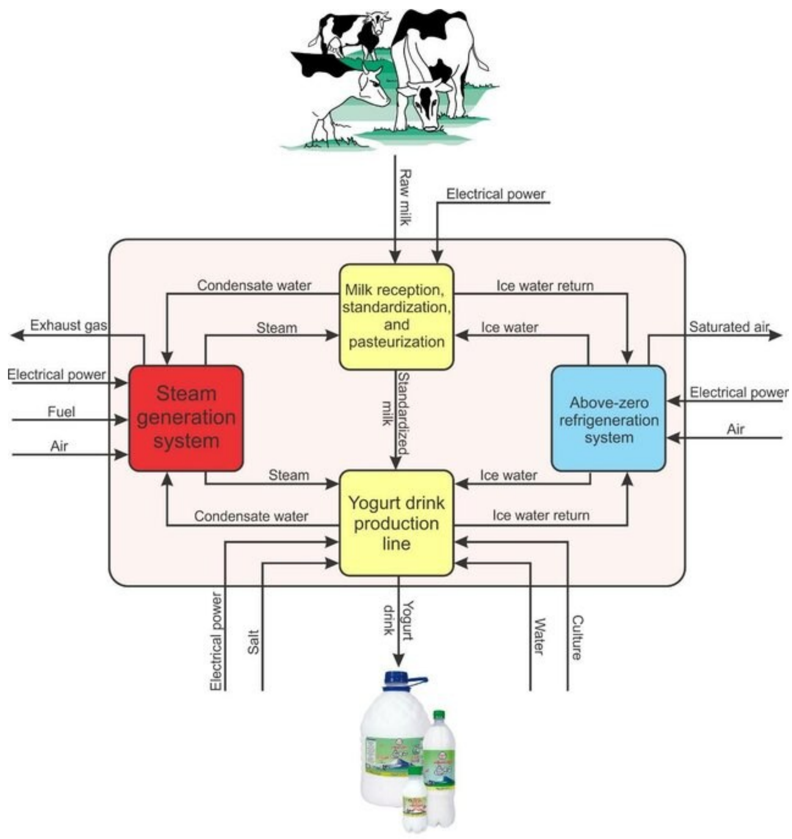

Figure 2. The diagram of flavored milk processing (Mojarab and Aghbashlo, 2017).

The flavored milk development resulted in a high-quality product with a fat content of 3.91%, protein at 3.30%, lactose at 4.96%, and a specific gravity of 1.032. The organoleptic tests conducted during the demonstration of preparing these products on the color, aroma, flavor, and texture were around 4.8- 5.4, meaning that the respondents about like these products. These ingredients were used to prepare the flavoured milk and mango yoghurt (Figure 3).

Pasteurizing milk | Flavours | Sugar | Mango paste | Yogurt starter

Figure 3. Ingredients for preparing the flavoured milk and mango yoghurt.

The benefits for farmers

The benefits and productivity gains from economic activities related to technology were satisfying. Introducing technologies of compost production, chilli hybrids for seedling transplants, and flavoured milk have gradually improved farmers' incomes, as shown in Table 6.

Table 6. The progress of production capacity and income of farmers after community service

No	Issues resolved	Production capacity		Income per month (Rp)	
		Before PKM	After 2 months PKM	Before PKM	After 2 months PKM
1	Production of organic compost and vermicompost (kg)/month	250	1.000	250.000	1.000.000
2	Supply of certified chilli seeds (seeds)	0	50	-	100.000
3	Processing of flavored milk (litres)/week	5	20	400.000	1.600.000
	Total			650.000	2.700.000

CONCLUSION

In conclusion, the findings indicate that combining farmyard materials with dairy farm waste effectively produces high-quality bokashi compost that meets SNI 19-7030-200 standards. The hybrid combination of UNIB C H63 x UNIB C H43 showed improved plant height and canopy area. In contrast, the single cropping of hybrids UNIB C H13 and UNIB C H53 enhanced resistance to yellow curly leaf disease. Additionally, the development of flavored milk resulted in a nutritious product with good fat, protein, and lactose content. Overall, the program successfully achieved its goals of producing quality compost, robust chilli hybrids, and healthy flavored milk.

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