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Formulated Liquid Biofertilizers: Chemical Properties and Bacterial Composition

***Mario B. Torred[1], Agripina R. Aradilla[2]**

1Mindanao State University-Buug Campus, Buug, Zamboanga Sibugay
[2]Central Mindanao University, University Town, Musuan, Bukidnon
*Corresponding Author: mbtorred@gmail.com

Abstract: *Biofertilizers are alternative nutrient source in sustainable crop production. The study was conducted to determine the chemical properties and bacterial components in three formulated biofertilizers intended for use in agricultural crops. The three formulated liquid biofertilizers (LBF), namely: cow ingesta, pig ingesta and their combination contain macro nutrient elements such as nitrogen, phosphorous, potassium, calcium, magnesium and sulphur and microelements iron, copper, manganese, zinc, sodium and boron which are essential for growth and development of crops. These also contain enterobacter species (Enterobacter cloacae and Enterobacter hafniae), which act as potassium solubilizers. The amount of chemical and bacterial components present did not vary among formulated liquid biofertilizers indicating that such formulations have equal potentials as source of nutrients in organic farming ventures.*

Keywords: liquid biofertilizers, adlay, Cow-Pig ingesta, potassium solubilizers

I. INTRODUCTION

Conventional agriculture has a significant role in food production to meet the demands of the populace which led to increase dependence on chemical fertilizers and pesticides [1]. Modern agriculture encourages the use of synthetic chemicals and fertilizers to increase crop yields. The food crops produced in this type of agricultural systems are not nutrient-rich; the use of chemical fertilizers contribute to air and ground water pollution [13]. With these scenario, a search for alternatives to synthetic fertilizers and pesticides are underway towards production of 'nutrient-rich high quality food' in a sustainable manner to ensure bio-safety [1]. Biofertilizers represent everything from manures to plant extracts [2] which increase soil fertility and crop production in sustainable farming. Biofertilizers contain living cells of different types of microorganisms that convert lock-up nutritionally important substances to available forms through biological processes [15, 13]. These nutrient-rich fertilizers when applied to seeds, plant surfaces, or soil, promotes growth by increasing the supply or availability of primary nutrients to the host plants [16]. However, biofertilizers need a carrier as medium for the microbial inoculants which are high in organic matter content and high water-holding capacity with favorable H^+ concentration [5]. Nutrient carriers must be free from microbial contamination, and has the capacity to optimize the growth of microorganisms [12]. Liquid biofertilizers (LBF) could be utilized as a nutrient carrier for crop plants and is a promising and updated technology of the conventional carrier-based production technology. LBF caters to long survival of the organism by providing the suitable medium which is sufficient for the entire crop cycle. Liquid inoculant formulations use various broth cultures amended with agents that promote cell survival in the package, and after application to seed or soil [6, 8]. The application of liquid broth formulation increases the shelf life of *Enterobacter hormaechei* which was used as a potassium solubilizer comparing to the solid formulation [11]. LBFs are believed to be the best alternative for the conventional carrier-based biofertilizers in modern agriculture [14]. Biofertilizers enhance soil fertility and supply or mobilize plant nutrients for crop nutrition with four categories: N fixers; P-solubilizing microorganisms; P mobilizers and organic matter decomposers. These may include cyanobacteria, symbiotic and free living bacteria and *Arbuscular Mycorhizal* fungi [7]. The plant growth-promoting *rhizobacteria* (PGPR) present in biofertilizers are active in ecosystem processes like biological control of plant pathogens, nutrient cycling and seedling establishment. PGPR may colonize the rhizosphere, the root surface, and intercellular spaces of plants. Nitrogen fixers are not only significant for legumes, but also non-legumes wherein some strains have multiple functions for plant growth. Phosphate (P)- and potassium (K)-solubilizing bacteria enhance mineral uptake by plants through solubilizing insoluble P and releasing K from silicate in soil [15]. Liquid formulation is a budding technology and has specific beneficial microorganisms capable of fixing or solubilizing or mobilizing plant nutrients by their biological activity [3].

Liquid fertilizer from the manure of cows, guinea pigs and pigs had been studied [4] as well as the use of animal manure and urine [9]. Animal urine was tried on the growth and yield performance of different agricultural crops [10]. With this scenario, his study sought to determine the chemical properties and bacterial components of three formulated liquid biofertilizers which could be utilized as source of nutrients for crops.

2. MATERIALS AND METHODS

2.1 Materials. The materials used in the formulation of liquid biofertilizer (LBF) were the following: 6 pcs 20 liter capacity containers with loose lid, 3 pcs 0.5 inch diameter hose couplings, 1.5 meters of 0.5 inch diameter transparent hose, 3 pcs empty 2

liter capacity plastic bottles, 6 kg of cow's ingesta, 6 kg of pig's ingesta, 3 kg of wood ash, 3 liters of fresh cow's milk, 3 liters of molasses, 1.5 kg of yeast, and 36 liters of tap water, adlay seeds (Gulian), liquid biofertilizer (LBFs), inorganic fertilizers, 30 pcs of 10" x 12" plastic pots, 0.5 kg tie wire, bamboo poles, nylon net, 300 kg top soil, shovel, hand trowel, bolo, camera, record notebook, pen, ruler, meter stick, portable sprayer (atomizer), and weighing scale.

2.2 Formulation of Liquid Biofertilizers. The three types of liquid biofertilizers were made by mixing 4 kg of cow ingesta, 4 kg of pig ingesta and 4kg of their combination (2 kg cow ingesta and 2 kg pig ingesta) and were placed in individual assigned 20 liter-capacity containers (Figure 1). The 12L tap water was added to each setup with 1 kg wood ash, 1L fresh cow's milk, 1L molasses. These were mixed thoroughly for 10 minutes before adding 0.5 kg of yeast to each container. The containers were covered tightly with its lid that has small opening connected to a 0.5 inch hose with the other end submerged in water in the bottle as aerator and outlet of pressure during fermentation process. Set-ups were placed in a shaded area for two months and after fermentation, the content of each container was filtered to extract the liquid biofertilizer and the liquid was placed in black container and kept at room temperature for laboratory tests and for future use in crop production.

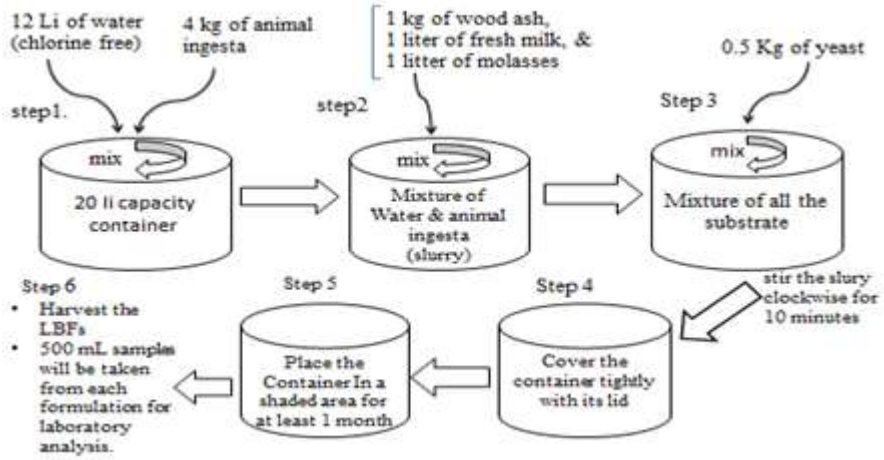

Fig. 1. Schematic presentation of the steps for LBFs formulation

2.3 Analysis of Liquid Biofertilizers. A 500 ml sample per formulation was placed in a sterilized plastic bottle and was submitted to UNIFRUTTI Philippines, Incorporated, Biotechnology and Research Services Analytical Laboratory, Lantapan, Bukidnon, Philippines for chemical analysis. Further, 250 ml per formulation were submitted to the Animal Diagnostic Laboratory of the College of Veterinary Medicine, Central Mindanao University, Musuan, Bukidnon, Philippines for bacterial count and identification.

3. RESULTS AND DISCUSSION

Chemical Analysis of Formulated LBFs. The laboratory analysis on the chemical properties of the formulated liquid biofertilizers is presented in Table 1.The result shows that the pH value of the three liquid biofertilizers is almost the same, ranging from 5.81 to 5.93 indicating moderate acidity. With regards to the primary macro nutrients (N - P_2O_5 - k_2O), content, pig ingesta liquid biofertilizer (PILBF) had the highest value of 0.31% followed by cow-pig ingesta liquid biofertilizer (CPILBF) with a value of 0.27% and the cow ingesta liquid biofertilizer got the lowest value of 0.26 of total nitrogen. For the total phosphorous as P_2O_5, CILBF and PILBF were of the same value of 0.07% while the CPILBF had only a value of 0.05%. For the total potassium as K_2O, CPILBF had the highest value of 0.34% followed by PILBF and CILBF with values of 0.32 and 0.27%, respectively. The LBFs also contain more of sulfur which was highest in pig ingesta LBF (321.56 ppm), followed by cow-pig ingesta LBF (310.59ppm) and cow ingesta with only 202.12 ppm. The LBFs also contain small amounts of Calcium and Magnesium. Likewise, there are also micronutrients present in all kinds of LBFs such as Iron, Copper, Manganese, Zinc, Sodium and Boron. The LBFs are considered complete of both macro and micronutrient elements which are essential for the growth and development of crops.

Table 1. Chemical properties of the three liquid biofertilizer formulations

ELEMENTS	COW INGESTA	PIG INGESTA	COW-PIG INGESTA
Ph	5.81	5.93	5.88
Total N (%)	0.26	0.31	0.27
Total P (%)	0.03	0.03	0.02
Total P as P_2O_5 (%)	0.07	0.07	0.05
Total K (%)	0.22	0.26	0.28
Total K as K_2O (%)	0.27	0.32	0.34
Total Ca (%)	0.09	0.38	0.41
Total Ca as CaO (%)	0.12	0.53	0.57
Total Mg (%)	0.10	0.15	0.11
Total Mg as MgO (%)	0.17	0.26	0.19
Total S, ppm	202.12	321.56	310.59
Total Fe, ppm	36.52	39.20	26.82
Total Cu, ppm	1.35	1.39	1.41
Total Mn, ppm	9.81	7.01	5.42
Total Zn, ppm	2.25	2.40	2.89
Total Na, ppm	35.08	35.11	35.14
Total B, ppm	25.50	25.07	24.95

Source: Biotechnology and Research Services Analytical Laboratory of UNIFRUTTI, Philippines, Incorporated

Bacterial Species in the Liquid Biofertilizers. Table 2 presents the result of the bacterial count and identification of the three LBF being done in the Animal Diagnostic Laboratory, College of Veterinary Medicine-CMU. The three LBFs contain different species of *Enterobacter* which are known to be potassium solubilizers (Prajapati *et al*., 2014). CILBF had 550 cfu/ml of *Enterobacter cloacae* while both PILBF and CPILBF had *Enterobacter hafniae* with 5,233 cfu/ml and 3,390 cfm/ml, respectively.

Table 2. Bacterial species and counts in the three liquid biofertilizers

LIQUID BIOFERTILIZERS	BACTERIA	COLONY FORMING UNIT (CFU)/ml
Cow Ingesta LBF	*Enterobacter cloacae*	550
Pig Ingesta LBF	*Enterobacter hafniae*	5,233
Cow-Pig Ingesta LBF	*Enterobacter hafniae*	3,390

Source: Animal Diagnostic Laboratory, College of Veterinary Medicine, Central Mindanao University, Musuan, Bukidnon, Philippines

CONCLUSION AND RECOMMENDATION

The three LBF formulations are potential and profitable source of natural nutrients for sustainable organic farming. It contains both macro (nitrogen, phosphorous, potassium, calcium, magnesium and sulphur) and micro (iron, copper, manganese, zinc, sodium and boron) nutrients essential for growth and development of the crops. These also contain *enterobacter species* (*Enterobacter cloacae* and *Enterobacter hafniae)* which are said to be potassium solubilizers. However, the chemical properties and bacterial components of the home-made biofertilizers did not vary among formulations which may suggest that these are all potential sources of nutrients for crops.

REFERENCES

[1] Bhardwaj, D., Ansari, M. W., Sahoo, R. K. & Tuteja, N. (2014). Biofertilizers function as key player in sustainable agriculture by improving soil fertility, plant tolerance and crop productivity. *Microbial Cell Factories, 13* (66).

[2] Bhattacharjee, R. & Dey, U. (2014). Biofertilizer, a way towards organic agriculture: A review. *African Journal of Microbiology Research 8*(24):2332-2342.

[3] Chandra, K., Greep, S., Ravindranath, P. & Srivathsa, R. S. H. (2005). Liquid Biofertilizers. Regional Centre of Organic Farming, Bangalore. p 64.

[4] Criollo, H., Lagos, T., Piarpuezan, E. & Pérez, R. (2011). The effect of three liquid bio-fertilizers in the production of lettuce (Lactuca sativa L.) and cabbage (Brassica oleracea L.var.capitata).*Agronomía Colombiana*, Septiembre-Diciembre, 415-421.

[5] Gaind, S. & Gaur, A. C. (1990). Shelf life of phosphate-solubilizing inoculants as influenced by type of carrier, high temperature, and low moisture. *Canadian Journal of Microbiology 36*:846-849.

[6] Girisha H. C, Brahmaprakash, G. P. & Manjunath, A. (2006). Liquid inoculant technology: A boon to pulse production. *Biofertilizer. Newsletter, 14* (1): 3-8.

[7] Khare, M. N. &, Tiwari, S. P. (2012). Microbial technology for sustainable organic agriculture. A Review. *JNKVV Research Journal, 46* (1).

[8] Kumaresan, G. & Reetha, D. (2011). Survival of *Azospirillum brasilense* in liquid formulation amended with different chemical additives. *Journal of Phytology, 3* (10), 48-51.

[9] Leksono, A. S., Yanuwiadi, B. (2014). The effect of bio and liquid organic fertilizer on weight and quality of apple. *International Journal of Agronomy and Agricultural Research (IJAAR); 5* (5), 53-58.

[10] Patil, P., Ghag, P. and Patil, S. (2013). Use of Bio-fertilizers and Organic Inputs - as LISA technology by farmers of Sangamner.*International Journal of Advancements in Research & Technology, 2* (7).

[11] Prajapati, K. & Modi, H. A. (2014). The Study of Shelf Life of Potassium Solubilizing Microorganisms for Liquid Biofertilizer. *Biotechnology, 3* (6).

[12] Phua, C. K. H., Abdul Wahid, A. N. & Abdul Rahim, K. (2012). Development of multifunctional biofertilizer formulation from indigenous microorganisms and evaluation of their N_2-fixing capabilities on Chinese Cabbage Using 15N Trace Technique. *Pertanika Journal of Tropical Agricultural Science*. Vol. 35 (3), pp. 673-679.

[13] Singh, R. P., Kumar, S., Sainger, M. & Singh, A.K. (2013). New Generation Eco-friendly Plant Nutrients for Sustainable Agriculture. *EnviroNews Archives .19 (*4).

[14] Sharma, M. P., Sharma, S. K. & Dwivedi, A. (2010). Liquid Biofertilizer Application in Soybean and Regulatory Mechanisms. Agriculture Today 2010.

[15] Verma, M., Sharma, S. & Prasad, R. (2011). Liquid Biofertilizers: Advantages over Carrier Based Biofertilizers for Sustainable CropProduction. *Archives of EnviroNews* -Newsletter of ISEB India, 17 (2).

[16] Vessey, J. K. (2003). Plant growth promoting rhizobacteria as biofertilizer. *Plant and Soil*. 255: 571-586.

[17] Youssef, M. M. A. & Eissa, M. F. M. (2014). Biofertilizers and their Role in Management of Plant Parasitic Nematodes. A review. *Journal of Biotechnology and Pharmaceutical Research, 5* (1). 001-006.

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