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Growth-Enhancing Potential of Chicken Feather Waste Hydrolyzed by *Serratiamarcescens* and *Klebsiellapneumoniae*for Cultivation of Beans (*Phaseolus vulgaris*) andCowpea (*Vignaunguiculata*) obtained from Akure, Ondo State, Nigeria

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ABSTRACT: The fermentation of chicken feather wastes into valuable products, such as organic liquid fertilizer by *Serratia marcescens* and *Klebsiellia pneumoniae* could serve as a great advantage for sustainable agricultural practices. Hence, the objective of this paper was to assess the growth-enhancing potential ofchicken feather waste hydrolyzed by*Serratia marcescens* and *Klebsiella pneumoniae* for cultivation of beans (*Phaseolus vulgaris)*and cowpeas (*Vigna unguiculata)*obtained from Akure, Ondo State, Nigeria using appropriate standard techniques.The proximate compositions of the chicken feather waste showed 77% crude protein content.The chicken feather waste has a mineral composition of 4.20% Nitrogen, 4.06% Phosphorus, and 0.32% Magnesium, the lowest. 76% and 72% of chicken feather waste were degraded by *Serratia marcescens* BKM-2 and *Klebsiella pneumoniae* BKM-3 respectively. The results showed that 30 ml of *Klebsiellapneumoniae*BKM-3 feather waste hydrolysate, has its best growth performance observed for*Phaseolus vulgaris* and *Vigna unguiculata* cultivars with 20.74 cm plant height, 4.56 cm leaf length, and 5.00 number of leaves and 24.37 cm plant height, 3.74 cm leaf length with 5.00 number of leaves at 15 days respectively compared to 15 ml and 45 ml.

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Keywords: Growth-Enhancing; *Phaseolus vulgaris; Vigna unguiculata;* Fermentation; Chicken Feather; Waste

The poultry industry makes a significant contribution to the global economy through the production of chicken meat and eggs, providing an important source of protein, but it generate a large amount of waste in the form of feathers, which are not biodegradable and represent a significant environmental impact. According to a study by the United States Department of Agriculture, approximately 100.5 million tons of meats were produced in 2020. As a result, over 4.7 million tons of chicken feathers were produced worldwide (Qiu *et al*., 2020). Feathers are more than 90% protein, and their main component is keratin. Keratin is a mechanically durable protein that is highly cross-linked by disulfide and other bonds (Tamilkani *et al*., 2017). This feather waste is a very good source of proteins and amino acids that can be used for various biotechnological applications (Kani *et al*., 2012). Several species of feather-degrading bacteria, actinomycetes, and fungi have been used to produce the enzyme keratinase. Keratin can be degraded by keratinases produced by several bacterial species such as *Bacillus cereus*, *Bacillus licheniformis*, *Bacillus*

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subtilis, Arthrobacter spp, and *Kocuriarosea,* and fungi such as *Aspergillus niger*, *Aspergillus flavus*, *Rhizomucor* sp., *Alternaria radicina*, *Absidia* sp., *Onygena* sp., and *Penicillium* sp (Vidmar and Vodovnik, 2018). Organic liquid fertilizer (chicken feather hydrolysate) could serve as a sustainable alternative to chemical fertilizers in agriculture. The resulting organic liquid fertilizer can act as a nutrient-rich source for plants, promote soil fertility, and increase crop productivity (Suhag, 2016). Feather meal is a cheap and readily available source of nitrogen and thereby serves as a potential biofertilizer (Jeong *et al*., 2010). The plant growth promoting effect of fermented chicken feather hydrolysate could also be effectively utilized in sustainable agricultural practices (Tiwary and Gupta, 2010). Therefore, the objective of this paper is to assess the growth-enhancing potential of chicken feather waste hydrolyzed by *Serratia marcescens* and *Klebsiella pneumoniae* forcultivation of beans (*Phaseolus vulgaris*) and cowpea (*Vigna unguiculata*) obtained from Akure, Ondo State, Nigeria.

MATERIALS AND METHOD

Microorganisms: Serratiamarcescens BKM-2 and *Klebsiella pneumoniae* BKM-3 were obtained from stored microorganisms in the Department of Microbiology, FUTA, Akure. These bacteria were recovered by transferring them into a Petri dish with 20 ml of culture medium nutrient agar (NA) andincubated at 37°C respectively.

Screening of the microorganisms: Serratiamarcescens BKM-2 and *Klebsiella pneumoniae* BKM-3 were screened to confirm their keratolytic properties. Skim milk agar was prepared (composition: 5 g/L of casein, 1 g/L of glucose, 3 g/L of skimmed milk powder, 25 g/L of yeast extract, and 15 g/L of agar) in a conical flask and sterilized in the autoclave at 121 °C for 15 minutes. After cooling, about 20 ml of the sterile skim milk agar was poured aseptically into sterile Petri dishes and allowed to solidify. An inoculum from the pure culture isolates was picked using a sterile inoculating loop and it was inoculated by stabbing the surface of the solidified medium in 4-5 places at a distance apart. The inoculated Petri dishes were incubated at 37 °C for 18-24 hours. *Determination of the proximate and mineral composition of the chicken feather waste*: The proximate and mineral composition of the chicken feather waste was analyzed as described by the Association of Official Analytical Chemists (AOAC, 2012) approach and each value was recorded. This analysis helps determine the nutritional composition of the waste.

*Application of Chicken feather waste Hydrolysate as growth enhancers on selected cultivars:*Seeds of *Phaseolus vulgaris* and*Vignaunguiculata* were obtained from the Ministry of Agriculture, Akure, Ondo State for planting in this research. The seeds were soaked in a bowl of water to separate viable seeds from non-viable seeds as the viable seeds sank to the bottom of the bowl while the non-viable seeds floated and were subsequently discarded. The soil sample was sourced from fertile farmland along the School of Agriculture walkway in the Federal University of Technology, Akure (FUTA), and was sterilized to eliminate indigenous soil microorganisms. Grow bags were obtained for planting and the grow bags were divided into different 3 groups containing different soil mixtures namely;

A: Soil containing different hydrolysate concentrations (15 ml, 30 ml, and 45 ml) of *Serratia marcescens* BKM-2,

B: Soil containing different hydrolysate concentrations (15 ml, 30 ml, and 45 ml) of *Klebsiella pneumoniae* BKM-3 and,

C: seed planted in soil without additives (Control). They were planted in triplicates in grow bags and were watered daily for 15 days. The height, leaf length, and number of leaves of the cultivars were measured throughout this duration.

RESULTS AND DISCUSSION

Table 1 and 2shows the morphological and biochemical characteristics of Serratia marcescens BKM-2 and Klebsiellia pneumoniae BKM-3. *Klebsiella pneumoniae* BKM-3 is a Gram-negative, rod-shaped bacterium that belongs to the Enterobacteriaceae family commonly found in the environment, including in water, soil, and on plants. *Serratia marcescens* BKM-2is observed to be light brown, circular shaped with a slimy texture. It's a gram-negative short-rod bacterium commonly found in soil.

Table 1: Morphological characteristics of bacteria

Bacteria	Colour	Margin	Elevation	Shape	Texture
Serratia marcescens	Light brown	Entire	Raised	Circular	Slimy
Klebsiellia pneumoniae	Creamy	Entire	Flat	Circular	Mucoid

Table 2: Biochemical characteristics of bacteria

Isolate	Gram Staining	Shape	Mannitol	Methyl Red	VP	Citrate	Catalase	Coagulase	Indole	Glucose	Lactose	Sucrose	Gas Formation	Motility	Urease	H_2S
A	-	R	+	-	+	+	+	-	-	+	+	+	-	+	+	-
B	-	R	+	-	-	+	+	-	-	+	+	+	-	-	+	-

Key: A-*Serratiamarcescens*, B-*Klebsiellia pneumoniae*, + (Positive), - (negative)

The appearance of a clear halo zone of hydrolysis on skim milk agar ascertains a positive indication of the keratinolytic activity of the bacteria. *Serratia marcescens* BKM-2 has its halo zone of inhibition measured at 2.2 cm while*Klebsiella pneumoniae* BKM-3 measured at 1.8 cm respectively (Figure 1).

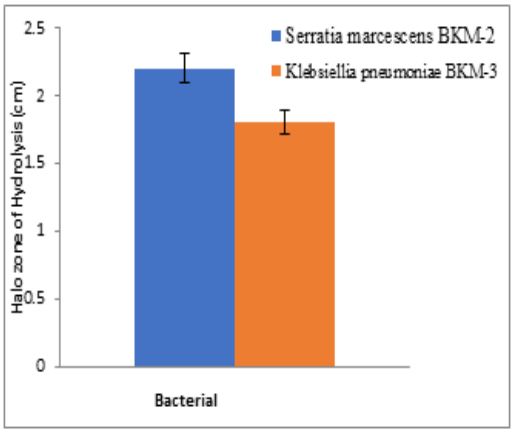

Fig 1: Zone of hydrolysis measured on Skim milk agar

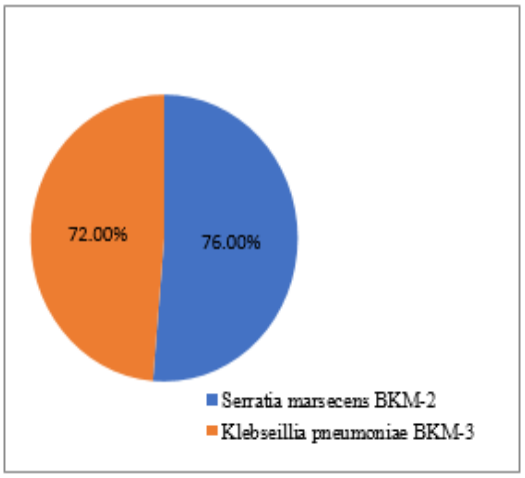

Fig 2: Chicken feather waste degradation by *Serratia marcescens* BKM-2 and *Klebsiella pneumoniae* BKM-3 after 7 days of submerged fermentation

The effective degradation of chicken feather waste at 76.00% by *Serratia marcescens* BKM-2 and 72.00% by *Klebsiella pneumoniae* BKM-3 respectively after seven (7) days of submerged fermentation (figure 2) with feathers as a source of carbon confirms their ability to degrade keratinolytic wastes. The proximate compositions of the chicken feather waste before fermentation showed 77.04% crude protein content with the least moisture content of less than 1%. Gupta and Ramnani (2006) explain that chicken feathers contain a high percentage of protein, primarily keratin, ranging from 80-90%. This high protein content makes feathers a valuable resource for various biotechnological applications. Moisture content in feather waste is crucial as it affects the waste's shelf life and potential for microbial degradation. Higher moisture content can lead to faster decomposition and increased microbial activity (Sinkiewicz *et al*., 2017). The chicken featherwaste has a mineral composition of 4.20% nitrogen and 4.06% phosphorus with the least content of 0.32% Magnesium (figures 3 and 4). The high content of nitrogen and phosphorus in chicken feather wastes provides significant support for soil enrichment.

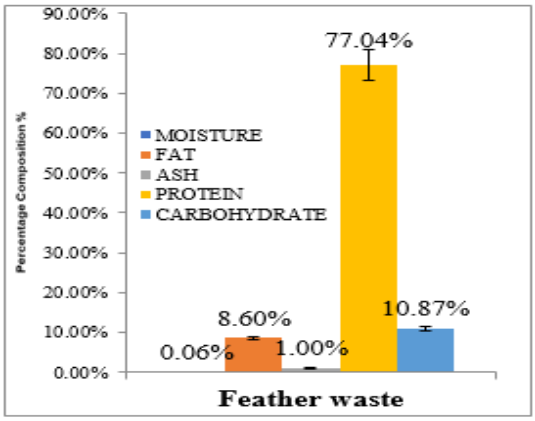

Fig 3: Proximate composition of chicken feather waste

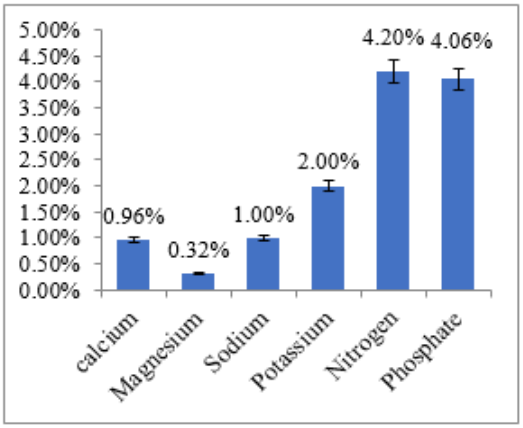

Fig 4: Mineral composition of chicken feather waste

Table 3: Growth of *Phaseolus vulgaris* cultivars using *Serratia marcescens*BKM-2 hydrolysate at different concentrations

Days	Plant Height (cm)	15ml Leaf Length (cm)	No of leaves	Plant Height (cm)	30ml Leaf Length (cm)	No of leaves	Plant Height (cm)	45ml Leaf Length (cm)	No of leaves
1-2	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
3	2.99±0.74^{a}	1.04±0.04^{a}	2.00±0.00^{a}	3.17±0.44^{b}	1.22±0.01^{a}	2.00±0.00^{ab}	3.36±0.93^{a}	1.53±0.03^{a}	2.00±0.00^{a}
4	3.40±0.47^{b}	1.24±0.04^{a}	2.00±0.00^{ab}	5.04±0.00^{c}	1.26±0.01^{a}	2.00±0.00^{b}	5.44±0.02^{c}	1.57±0.05^{a}	2.00±0.00^{b}
5	4.04±0.19^{b}	1.47±0.06^{a}	2.00±0.00^{a}	6.47±0.09^{c}	1.47±0.02^{a}	2.00±0.00^{b}	7.48±0.04^{c}	1.61±0.06^{a}	2.00±0.00^{b}
6	4.79±0.04^{b}	1.81±0.05^{a}	2.00±0.00^{a}	7.39±0.23^{b}	1.64±0.03^{a}	2.00±0.00^{a}	8.32±0.20^{b}	1.75±0.04^{a}	2.00±0.00^{a}
7	6.46±0.21^{b}	2.08±0.03^{a}	2.00±0.00^{a}	9.39±0.19^{b}	2.04±0.04^{a}	2.00±0.00^{a}	9.97±0.68^{b}	2.18±0.18^{a}	2.00±0.00^{a}
8	7.39±0.18^{b}	2.30±0.08^{a}	2.00±0.00^{a}	10.88±0.82^{b}	2.05±0.02^{a}	2.00±0.00^{a}	12.12±0.04^{b}	2.14±0.04^{a}	2.00±0.00^{a}
9	8.64±0.32^{b}	2.50±0.13^{a}	2.00±0.00^{a}	12.08±1.08^{b}	2.15±0.02^{a}	2.00±0.00^{a}	13.68±0.37^{b}	2.46±0.17^{a}	2.00±0.00^{a}
10	9.45±0.20^{c}	2.98±0.02^{a}	5.00±0.00^{b}	14.65±0.15^{c}	2.25±0.01^{a}	5.00±0.00^{b}	15.25±0.73^{c}	2.84±0.46^{a}	5.00±0.00^{a}
11	10.53±0.37^{c}	3.13±0.10^{a}	5.00±0.00^{b}	15.38±0.28^{c}	2.53±0.01^{a}	5.00±0.00^{b}	16.17±0.84^{b}	3.13±0.57^{a}	5.00±0.00^{a}
12	11.54±0.22^{c}	3.25±0.06^{a}	5.00±0.00^{b}	16.62±0.62c	2.60±0.05^{a}	5.00±0.00^{b}	16.90±0.90^{b}	2.96±0.06^{a}	5.00±0.00^{a}
13	12.02±0.21^{c}	3.38±0.00^{a}	5.00±0.00^{b}	17.50±0.08^{c}	3.11±0.05^{a}	5.00±0.00^{b}	17.08±0.92^{b}	3.22±0.03^{a}	5.00±0.00^{a}
14	12.37±0.37^{c}	3.33±0.17^{a}	5.00±0.00^{b}	18.65±0.65^{c}	3.20±0.02^{a}	5.00±0.00^{b}	18.09±1.45^{b}	3.34±0.08^{a}	5.00±0.00^{a}
15	12.82±0.75^{c}	3.35±0.31^{a}	5.00±0.00^{b}	19.06±1.05^{c}	3.36±0.06^{a}	5.00±0.00^{b}	18.34±1.66^{b}	3.44±0.12^{a}	5.00±0.00^{a}

Data are presented as Mean ± S.E (n=3). Values with the same superscript letter(s) along the same rows are not significantly different (p>0.05) according to Duncan's New Multiple Range

Table 4: Growth of *Phaseolus vulgaris* cultivarsusing *Klebsiella pneumoniae* BKM-3 hydrolysate at different concentrations

DAYS	Plant Height (cm)	15ml Leaf Length (cm)	No of leaves	Plant Height (cm)	30ml Leaf Length (cm)	No of leaves	Plant Height (cm)	45ml Leaf Length (cm)	No of Leaves
1-2	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
3	3.14±0.41^{b}	1.42±0.12^{a}	2.00±0.00^{ab}	3.17±0.44^{a}	1.06±0.06^{a}	2.00±0.00^{a}	3.06±0.43^{b}	1.28±0.08^{a}	2.00±0.00^{a}
4	5.04±0.78^{b}	1.75±0.13^{a}	2.00±0.00^{a}	4.69±0.35^{b}	1.36±0.01^{a}	2.00±0.00^{a}	4.99±0.37^{b}	1.52±0.10^{a}	2.00±0.00^{a}
5	6.59±1.46^{a}	2.08±0.05^{a}	2.00±0.00^{a}	6.67±0.12^{b}	2.37±0.09^{a}	2.00±0.00^{a}	6.68±0.87^{b}	1.73±0.08^{a}	2.00±0.00^{a}
6	7.82±1.99^{a}	2.86±0.10^{a}	2.00±0.00^{a}	7.84±0.22^{b}	2.59±0.08^{a}	2.00±0.00^{a}	7.87±0.15^{b}	1.85±0.07^{a}	2.00±0.00^{a}
7	9.28±1.61^{b}	3.19±0.07^{a}	2.00±0.00^{a}	9.69±0.19^{c}	3.04±0.04^{b}	2.00±0.00^{a}	9.62±0.23^{b}	2.18±0.08^{a}	2.00±0.00^{a}
8	10.32±1.76^{b}	3.40±0.02^{a}	2.00±0.00^{a}	12.23±0.23^{c}	3.10±0.07^{b}	2.00±0.00^{a}	11.22±0.06^{c}	2.39±0.09^{b}	2.00±0.00^{a}
9	11.65±2.33^{b}	3.69±0.07^{a}	2.00±0.00^{a}	13.83±0.03^{c}	3.20±0.07^{b}	2.00±0.00^{a}	13.13±0.09^{c}	2.53±0.11^{b}	2.00±0.00^{a}
10	12.69±2.34^{b}	4.04±0.04^{a}	5.00±0.00^{a}	15.60±0.10^{c}	3.30±0.04^{a}	5.00±0.00^{b}	14.95±0.13^{c}	3.05±0.47^{a}	5.00±0.00^{b}
11	14.10±2.20^{b}	4.23±0.01^{a}	5.00±0.00^{a}	16.38±0.00^{c}	3.58±0.04^{a}	5.00±0.00^{b}	15.87±0.24^{c}	3.56±0.10^{a}	5.00±0.00^{b}
12	14.96±2.64^{b}	4.95±0.65^{a}	5.00±0.00^{a}	17.62±0.02^{c}	4.03±0.03^{a}	5.00±0.00^{b}	17.42±0.52^{c}	3.62±0.10^{a}	5.00±0.00^{a}
13	16.14±2.33^{b}	4.59±0.21^{a}	5.00±0.00^{a}	18.70±0.12^{c}	4.21±0.05^{a}	5.00±0.00^{b}	18.25±0.39^{c}	3.74±0.12^{a}	5.00±0.00^{a}
14	17.27±2.57^{b}	4.58±0.18^{a}	5.00±0.00^{a}	19.90±0.01c	4.30±0.09^{a}	5.00±0.00^{b}	19.24±0.40^{c}	3.81±0.11^{a}	5.00±0.00^{a}
15	18.33±2.25^{b}	4.80±0.24^{a}	5.00±0.00^{a}	20.74±0.31^{c}	4.56±0.26^{b}	5.00±0.00^{a}	19.82±0.14^{c}	3.94±0.12^{a}	5.00±0.00^{b}

Data are presented as Mean ± S.E (n=3). Values with the same superscript letter(s) along the same rows are not significantly different (p>0.05) according to Duncan's New Multiple Range

Table 5: Growth of *Phaseolus vulgaris* cultivars with normal soil

DAYS	Plant Height (cm)	Control Leaf Length (cm)	No of leaves
1-2	0.00±0.00	0.00±0.00	0.00±0.00
3	2.28±0.08^{b}	1.22±0.19^{a}	2.00±0.00^{b}
4	4.03±0.51^{b}	1.62±0.06^{a}	2.00±0.00^{a}
5	4.80±0.24^{b}	1.85±0.06^{a}	2.00±0.00^{a}
6	5.93±0.50^{b}	1.90±0.06^{a}	2.00±0.00^{a}
7	8.32±0.28^{b}	2.41±0.16^{a}	2.00±0.00^{a}
8	9.41±0.16^{b}	2.35±0.14^{a}	2.00±0.00^{a}
9	10.48±0.92^{b}	2.50±0.12^{a}	2.00±0.00^{a}
10	11.33±0.90^{b}	3.02±0.02^{a}	5.00±0.00^{a}
11	12.54±1.22^{b}	3.22±0.02^{a}	5.00±0.00^{a}
12	14.54±0.73^{b}	3.22±0.02^{a}	5.00±0.00^{a}
13	15.04±0.99^{b}	3.73±0.05^{a}	5.00±0.00^{a}
14	16.11±0.75^{b}	3.95±0.01^{a}	5.00±0.00^{a}

Data are presented as Mean ± S.E (n=3). Values with the same superscript letter(s) along the same rows are not significantly different (p>0.05) according to Duncan's New Multiple Range

Bhari *et al.*, (2021) affirm that the natural source of these essential elements enhances soil fertility and plant growth. The results showed that 30 ml of *Klebsiellapneumoniae*BKM-3 feather waste hydrolysate, has its best growth performance observed for*Phaseolus vulgaris* and *Vignaunguiculata* cultivars

with 20.74 cm plant height, 4.56 cm leaf length, and 5.00 number of leaves and 24.37 cm plant height, 3.74 cm leaf length with 5.00 number of leaves at 15 days respectively compared to 15 ml and 45 ml. An inoculum volume of 15 ml *Serratiamarscecens*BKM-2 is most beneficial for*Vignaunguiculata* growth in terms of height, number of leaves, and leaf length, suggesting that higher volumes may have a detrimental effect on their growth.

Table 6: Growth of *Vignaunguiculata* cultivars with*Serratia marcescens* BKM-2 hydrolysate at different concentrations

DAYS	Plant Height (cm)	15ml Leaf Length (cm)	No of leaves	Plant Height (cm)	30ml Leaf Length (cm)	No of leaves	Plant Height (cm)	45ml Leaf Length (cm)	No of leaves
1-2	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
3	3.22±0.51^{b}	1.00±0.00^{a}	2.00±0.00^{a}	2.72±0.12^{c}	1.22±.0.01^{a}	2.00±0.00^{b}	2.48±0.05^{c}	1.53±0.03^{a}	2.00±0.00^{b}
4	5.52±0.02^{c}	1.59±0.01^{a}	2.00±0.00^{b}	5.02±0.02^{c}	1.26±0.0^{a}	2.00±0.00^{b}	5.48±0.03^{c}	1.65±0.03^{a}	2.00±0.00^{b}
5	7.89±0.45^{b}	1.82±0.09^{a}	2.00±0.00^{a}	6.53±0.02^{c}	1.47±0.02^{a}	2.00±0.00^{b}	7.50±0.06^{c}	1.64±0.01a	2.00±0.00^{b}
6	9.08±0.06^{b}	1.91±0.05^{a}	2.00±0.00^{a}	7.47±0.15^{b}	1.64±0.03^{a}	2.00±0.00^{a}	8.09±0.03^{c}	1.79±0.02^{a}	2.00±0.00^{b}
7	12.59±0.08^{b}	2.28±0.23^{a}	2.00±0.00^{a}	9.56±0.02^{b}	2.04±0.02^{a}	2.00±0.00^{a}	9.26±0.03^{c}	2.10±0.07^{b}	2.00±0.00^{b}
8	14.05±0.49^{b}	2.20±0.02^{a}	2.00±0.00^{a}	11.50±0.20^{b}	2.05±0.02^{a}	2.00±0.00^{a}	12.51±0.35^{b}	2.15±0.04^{a}	2.00±0.00^{a}
9	15.67±0.35^{b}	2.40±0.03^{a}	2.00±0.00^{a}	13.10±0.05^{b}	2.15±0.02^{a}	2.00±0.00^{a}	13.21±0.10^{b}	2.21±0.02^{a}	2.00±0.00^{a}
10	18.36±0.30^{c}	3.03±0.03^{a}	5.00±0.00^{b}	14.51±0.01^{c}	2.25±0.01^{a}	5.00±0.00^{b}	14.62±0.10^{c}	2.29±0.01^{a}	5.00±0.00^{b}
11	18.25±0.35^{c}	3.24±0.10^{a}	5.00±0.00^{b}	15.61±0.05^{c}	2.53±0.01^{a}	5.00±0.00^{b}	15.45±0.12^{c}	2.38±0.02^{a}	5.00±0.00^{b}
12	19.44±0.12^{c}	3.35±0.05^{a}	5.00±0.00^{b}	17.14±0.10^{c}	2.60±0.05^{a}	5.00±0.00^{b}	16.01±0.01^{c}	3.06±0.04^{a}	5.00±0.00^{b}
13	20.20±0.62^{b}	3.53±0.05^{a}	5.00±0.00^{a}	17.54±0.04^{c}	3.11±0.05^{a}	5.00±0.00^{b}	16.14±0.03^{c}	3.32±0.03^{a}	5.00±0.00^{b}
14	21.28±0.28^{c}	3.78±0.02^{a}	5.00±0.00^{b}	19.19±0.10^{c}	3.20±0.02^{a}	5.00±0.00^{b}	16.59±0.06^{c}	3.39±0.03^{a}	5.00±0.00^{b}
15	23.06±0.02^{c}	3.90±0.06^{a}	5.00±0.00^{b}	20.06±0.05^{c}	3.36±0.06^{a}	5.00±0.00^{b}	16.88±0.00^{c}	3.57±0.09^{a}	5.00±0.00^{b}

Data are presented as Mean ± S.E (n=3). Values with the same superscript letter(s) along the same rows are not significantly different (p>0.05) according to Duncan's New Multiple Range

Table 7: Growth of *Vignaunguiculata* cultivars with *Klebsiella pneumoniae* BKM-3 hydrolysateat different concentrations

DAYS	Plant Height (cm)	15ml Leaf Length (cm)	No of leaves	Plant Height (cm)	30ml Leaf Length (cm)	No of leaves	Plant Height (cm)	45ml Leaf Length (cm)	No of leaves
1-2	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
3	3.16±0.10^{c}	1.07±0.02^{a}	2.00±0.00^{b}	3.17±0.12^{c}	1.53±0.01^{a}	2.00±0.00^{b}	2.45±0.00^{b}	1.20±0.00^{a}	2.00±0.00^{b}
4	5.19±0.15^{b}	1.85±0.10^{a}	2.00±0.00^{a}	4.43±0.03^{c}	1.63±0.03^{a}	2.00±0.00^{b}	3.42±0.00^{c}	1.42±0.00^{a}	2.00±0.00^{b}
5	6.53±0.10^{b}	1.91±0.01^{a}	2.00±0.00^{a}	6.65±0.03^{b}	1.97±0.01^{a}	2.00±0.00^{a}	4.35±0.00^{c}	1.65±0.00^{a}	2.00±0.00
6	9.33±0.25^{b}	1.92±0.02^{a}	2.00±0.00^{a}	8.33±0.02^{b}	2.01±0.01^{a}	2.00±0.00^{a}	5.06±0.00^{c}	1.80±0.00^{a}	2.00±0.00^{b}
7	11.57±0.05^{b}	1.95±0.03^{a}	2.00±0.00^{a}	10.25±0.00^{b}	2.13±0.00^{a}	2.00±0.00^{a}	7.02±0.00^{b}	2.02±0.01^{a}	2.00±0.00^{a}
8	15.11±0.01^{c}	2.04±0.02^{a}	4.00±0.00^{b}	12.43±0.01^{c}	2.11±0.05^{a}	4.00±0.00^{b}	9.40±0.00^{c}	2.06±0.01^{a}	4.00±0.00^{b}
9	16.60±0.15^{c}	2.14±0.02^{a}	4.00±0.00^{b}	13.24±0.02^{c}	2.28±0.01^{a}	4.00±0.00^{b}	10.51±0.00^{c}	2.14±0.01^{a}	4.00±0.00^{b}
10	18.33±0.03^{c}	2.24±0.04^{a}	5.00±0.00^{b}	15.37±0.03^{c}	2.33±0.02^{a}	5.00±0.00^{b}	12.14±0.00^{c}	2.13±0.05^{a}	5.00±0.00^{b}
11	18.64±0.04^{c}	2.20±0.05^{a}	5.00±0.00^{b}	16.30±0.05^{c}	2.65±0.03^{a}	5.00±0.00^{b}	13.46±0.00^{c}	2.25±0.02^{a}	5.00±0.00^{b}
12	18.73±0.15^{c}	3.28±0.05^{a}	5.00±0.00^{b}	16.66±0.09^{c}	3.51±0.01^{a}	5.00±0.00^{b}	15.42±0.00^{c}	3.12±0.02^{a}	5.00±0.00^{b}
13	19.63±0.03^{c}	3.43±0.05^{a}	5.00±0.00^{b}	18.19±0.10^{c}	3.44±0.02^{a}	5.00±0.00^{b}	17.33±0.00^{c}	3.24±0.04^{a}	5.00±0.00^{b}
14	20.74±0.02^{c}	3.47±0.05^{a}	5.00±0.00^{b}	21.29±0.25^{c}	3.64±0.04^{a}	5.00±0.00^{b}	19.28±0.00^{c}	3.35±0.01^{a}	5.00±0.00^{b}
15	22.42±0.10^{c}	3.60±0.05^{a}	5.00±0.00^{b}	24.37±0.05^{c}	3.74±0.02^{a}	5.00±0.00^{b}	20.10±0.00^{c}	3.45±0.03^{a}	5.00±0.00^{b}

Data are presented as Mean ± S.E (n=3). Values with the same superscript letter(s) along the same rows are not significantly different (p>0.05) according to Duncan's New Multiple Range

Table 8: Growth of *Vignaungui culata*cultivars using normal soil

DAYS	Plant Height (cm)	Control Leaf Length (cm)	No of leaves
1-2	0.00±0.00	0.00±0.00	0.00±0.00
3	2.25±0.25^{a}	1.22±0.19^{a}	2.00±0.00^{a}
4	4.00±0.50^{b}	1.62±0.06^{a}	2.00±0.00^{a}
5	4.75±0.25^{b}	1.85±0.06^{a}	2.00±0.00^{a}
6	5.80±0.50^{b}	1.90±0.06^{a}	2.00±0.00^{a}
7	8.00±0.00^{b}	2.41±0.16^{a}	2.00±0.00^{a}
8	9.00±0.50^{b}	2.35±0.14^{a}	2.00±0.00^{a}
9	9.75±1.25^{b}	2.50±0.12^{a}	2.00±0.00^{a}
10	11.00±1.00^{b}	3.02±0.02^{a}	2.00±0.00^{a}
11	11.75±1.75^{b}	3.22±0.12^{a}	5.00±0.00^{a}
12	13.50±0.70^{b}	3.46±0.07^{a}	5.00±0.00^{a}
13	14.00±1.00^{b}	3.53±0.05^{a}	5.00±0.00^{a}
14	14.90±0.60^{b}	3.70±0.04^{a}	5.00±0.00^{a}
15	15.60±0.10^{c}	3.79±0.03^{a}	5.00±0.00^{b}

Data are presented as Mean ± S.E (n=3). Values with the same superscript letter(s) along the same rows are not significantly different (p>0.05) according to Duncan's New Multiple Range

Plate 1: Photograph of *Phaseolus vulgaris* (White beans) on day 0, day 7, and day 15

Plate 2: Shows a photograph of *Vignaunguiculata* (Brown Beans) on day 0, day 7, and day 15 respectively.

The keratinolytic microbes' efficiency resulted in the enhanced growth observed in plants studied compared to those grown in normal soil without microbial supplements (Martínez-Hidalgo and Hirsch, 2017),

*Conclusion***:** The result of this study showed that *Serratia marcescens* BKM-2 *and Klebsiella pneumoniae* BKM- 3. Keratinolytic bacteria can be utilized to enhance the growth of *Vignaunguiculata and Phaseolus vulgaris* cultivars and are efficient for the degradation of chicken feather wastes.The indiscrimination of direct disposal of chicken featherwastes should be discouraged on farmlands. The larger significance of this research lies in its contribution to sustainable waste management and improved agricultural productivity.

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