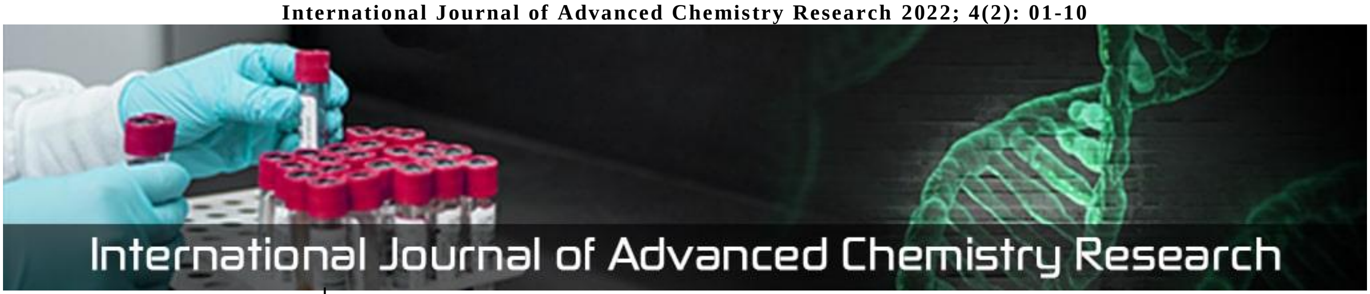

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Determination of the best combination of organic materials for enhanced 6-gingerol in ginger (*Zingiber officinale*): An effort towards enhancing the medicinal activity of ginger

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Abstract
Organic manure use to meet crop nutrient requirements is anticipated to become an inevitable practice for sustainable agriculture in the future, as it has been shown to improve soil physical, chemical, and biological qualities. It is also been frequently utilized to dispose of animal waste and reduce pollution. The objective of this study was to evaluate the influence of combination of organic material for enhanced 6-gingerol content of ginger hence field and laboratory experiments were carried out to evaluate this. The treatments used were Cow dung+ Sawdust at 50% each, Cow dung+ Poultry manure at 50% each, Poultry manure+ rice mill waste at 50% each, Rice mill waste + Sawdust at 50% each, absolute control (No amendments), Poultry manure + Sawdust at 50% each, Cow dung +Rice mill waste at 50%each and Poultrymanure + Rice mill waste + Sawdust + Cowdung at 25% each. Eight treatments were used and replicated three times using randomized complete block design (RCBD). 6-gingerol content of the harvested ginger was quantified in the laboratory using reverse phase high performance liquid chromatography. Data analysis was done using Open source R environment version 4.1.0 statistical software. The result showed that combination of organic amendments enhanced the 6-gingerol concentration of ginger at different rates. The plot amended with cowdung+poultry manure gave the highest value which was significantly different from the absolute control. 6-gingerol content of other combinations of organic materials used in this experiment were also significantly different from the control. The rank order of 6- gingerol content among the treatments were >cowdung + Poultry manure (476.5089 ug/ml) > Cowdung + Ricemillwaste,(467.1398 ug/ml)> Poultry Manure + Ricemillwaste + Sawdust + Cowdung (455,4349ug/ml)> Poultry manure + Rice mill waste (449.0128 ug/ml) > Cowdung + Sawdust (444.8956 ug/ml) >Poultry manure + Sawdust (434.4819 ug/ml) > Rice mill waste + Sawdust (428.5675 ug/ml) > Absolute Control (270.1886 ug/ml).. The result showed that use of cowdung manure +poultry manure at the rate of 134g and 157g respectively for a 2m bed gave the best result among the organic combinations used in this study..

Keywords: 6-gingerol, cowdung, poultry manure, rice mill waste, sawdust

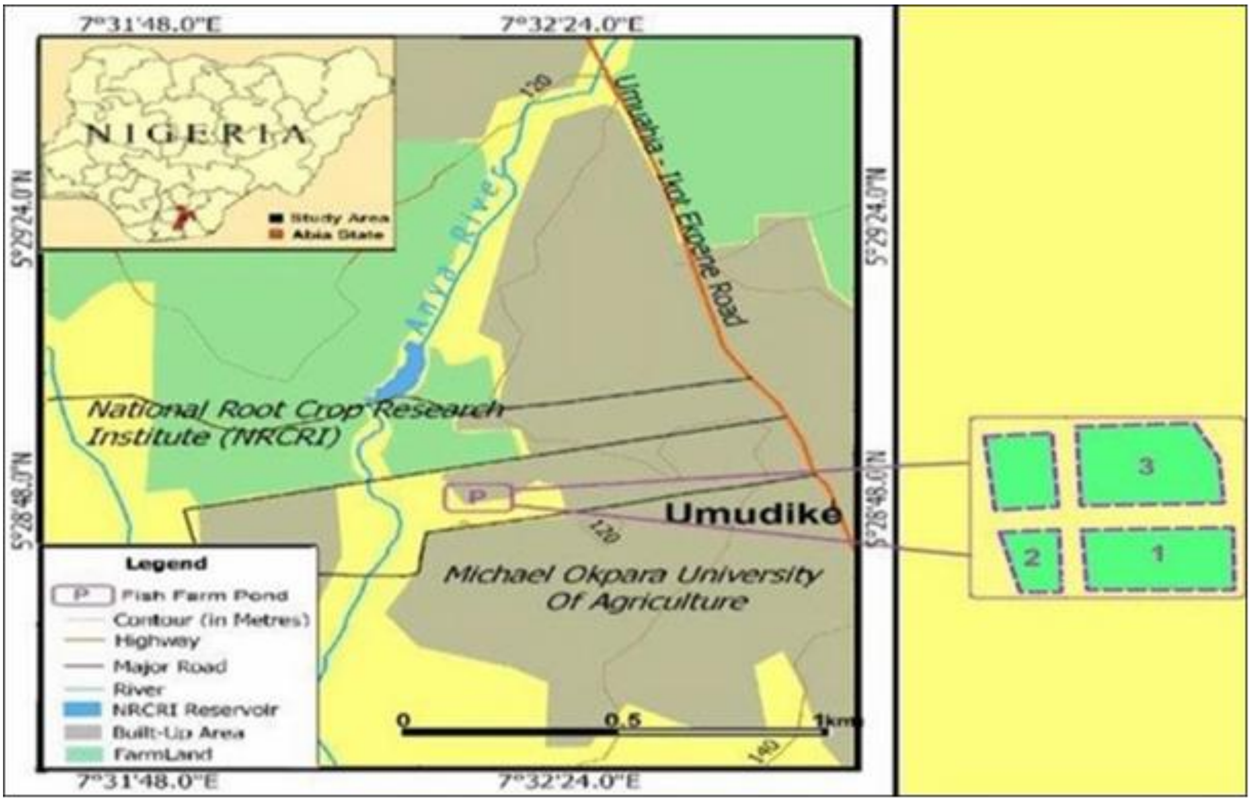
Introduction
Ginger (Zingiber officinale) is a member of the Zingiberaceae family and has been used as a spice and herbal medicine for centuries (Han *et al*., 2013). In recent years, there has been a surge in interest in the use of ginger all over the world. According to (stoner 2013), the presence of 6-gingerol (5-hydroxy – 1 – (4-hydroxy-3- methoxyphenyl) decan-3-one) is responsible for the majority of Ginger's therapeutic properties. Furthermore, numerous studies have shown that ginger has the potential to prevent and control a variety of ailments, including cardiovascular disease (Akinyemi *et al*. 2015) [1], obesity (Suk *et al* 2017) [11], neurological disease (ho *et al*. 2013), and respiratory disorder (Townsend *et al*. 2017) [13], and diabetes mellitus (Wei *et al*.). In recent years, ginger has also been found to possess anti-inflammatory (Zhang *et al*. 2016) [19], anticancer (Cintroberg *et al*. 2013) and antioxidant (Nile *et al*. 2015) activities.

Consumers are increasingly concerned about agrochemical exposure, particularly in fresh foods (Fortis-hernandiz *et al*., 2012) [4], implying that they want chemical-free foods. They have become highly interested in a better diet hence boosting their intake of ginger, fruits, and vegetables (Jahansson *et al*, 2014). Inorganic/chemical fertilizer has been shown to have significant harmful consequences on the environment and human health (Rande *et al* 2013). Manure as a soil amendment is preferred over chemical fertilizers because it minimizes pollution and improves food quality. Studies on ginger with organic and inorganic sources of fertilization have been primarily concerned with their productive qualities. This study therefore seeks to determine the best combination of organic materials that will improve the 6-gingerol (5-Hyoroxy-1-(4-hydroxy- 3-methoxyphenyl) decan-3-one) content of seed ginger.

Methodology

The Study Site

The field trial was executed at the National Root Crops Research Institute's Umudike field, which is located on the Umuahia Ikot-Ekpene Road at kilometer 7. It is at an altitude of 122 meters above sea level. The minimum temperature in the area is 22°C, while the maximum temperature is 32°C. The rainfall ranges between 2500 and 3000 mm.



Experimental Design and Manure Rates

The field experiment was carried out in a randomized complete block design with manure source: Poultry manure, Rice mill waste, Sawdust and Cow dung in factorial combination with manure rates of 50% (quantity required to supply 22.5kgN) and 25% (quantity required to supply 11.25kg N) replicated three times with a plot size of 1mx2 m, inter plot distance of 50cm and inter rep distance of 1m. Absolute control treatment (without amendment material) was also included. The Nitrogen content of the organic materials used in this experiment were analyzed in the lab using kjedahl method and found to be Cow dung (3.36% N), Poultry Manure (2.87% N), Rice Mill Waste (1.33% N), and Saw Dust (0.56% N). Cow dung (3.36% N) and applied at the rate of:

Cow dung (3.36% N) 50% ------134g/plot

25%---------67g/plot Poultry Manure (2.87% N)

50% ------157g/plot

25%---------78.5g/plot

Rice Mill Waste (1.33% N) 50% ------338.5g/plot

25%---------169.25g/plot

Saw Dust (0.56% N) 50% ------803.5g/plot
25%---------401.75g/plot

Sample Processing, Extraction and Quantification

After harvesting, the ginger rhizome was dried and grinded. 5g weighed and refluxed with methanol (100ml) for 15 minutes in a water bath and filtered through whatman filter paper (No.41). The residue left out was refluxed again three times with 70ml of methanol for 15 minutes and filtered. The solvent was then evaporated using a rotary vacuum evaporator. This procedure was performed for all the 15 different sample treatments. The extract was analyzed using reverse phase high performance liquid chromatography. Data analysis was statistically done in an open source R environment version 4.1.0. Further mean separation was done using HSD at 5%. Mobile Phase used was Acetronitrile: Water 55:45, Column: C18 – ODS (Octadeciylsilane) (Lichrocart 250-4, Lichrospher RP-18e-5m (merck)Art No:1.50216. The column size is150 X 4.6mm and at wavelength of 280nm

Results and Discussion

Reverse phase high performance liquid chromatography was used to quantify the quantity of 6-gingerol content of the ginger extract. The gingerol showed a UV absorption maximum at 280nm and retention time of 3.8 minutes. The result is shown in Table 1.

Table 1: Concentration of 6-gingerol in the harvested ginger

Treatments	Rep 1(ug/ml)	Rep 2(ug/ml)	Rep 3(ug/ml)	Mean(ug/ml)
Cow dung + Saw dust (50% each)	444.8664	445.0719	444.7489	444.8956
Cowdung+ Poultry Manure (50% each)	472.5540	476.0136	480.9591	476.5089
Poultry manure + Ricemillwaste (50%each)	452.9492	446.5108	447.5783	449.0128
Rice mill Waste + Sawdust (50%each)	432.6148	425.3433	427.7391	428.5657
Absolute control	269.7359	270.8640	269.9660	270.1886
Poultry Manure + Saw dust (50%each)	432.8720	433.5526	437.0210	434.4819
Cow dung + Rice mill waste (50%each)	470.9229	462.7813	467.7151	467.1398
Poultry manure +Rice mill waste + Saw dust + Cowdung	453.9085	459.3947	453.0015	455.4349
(25%each) Standard Control (NPK 15;15;15)	273.4033	273.4030	273.1302	273.3122

CD=Cow dung, PM=Poultry manure, SD=Sawdust, RMW=Rice mill waste

When all the treatments used in this experiment was statistically compared with the absolute control, they all had significant effect ($p<0.05$) on the 6-gingerol concentration of ginger as shown in table 2.

Table 2: Statistical Table (Treatment compared to Absolute control)

Treatment	Treatment - Absolute control	contrast	lower.CL	upper.CL	p-value
CD+PM	(CD+PM) - Absolute control	239.50	230.65	248.35	<.0001
CD+Rmw	(CD+Rmw) - Absolute control	230.13	221.28	238.98	<.0001
CD+SD	(CD+SD) - Absolute control	207.89	199.04	216.74	<.0001
PM+RMW	(PM+RMW) - Absolute control	212.01	203.16	220.85	<.0001
Pm+Rmw+SD+CD	(Pm+Rmw+SD+CD) - Absolute control	218.43	209.58	227.28	<.0001
PM+SD	(PM+SD) - Absolute control	197.47	188.63	206.32	<.0001
Rmw+SD	(Rmw+SD) - Absolute control	191.56	182.71	200.41	<.0001

Table 3: Statistical Table (Treatments compared to standard control) When all the treatments used in this experiment was statistically compared with the absolute control, they all had

Treatment	Treatment - Standard control	contrast	SE	df	lower.CL	upper.CL	p-value
CD+PM	(CD+PM) - Standard control	203.20	2.55	24.00	194.35	212.05	<.0001
CD+Rmw	(CD+Rmw) - Standard control	193.83	2.55	24.00	184.98	202.68	<.0001
CD+SD	(CD+SD) - Standard control	171.59	2.55	24.00	162.74	180.43	<.0001
PM+RMW	(PM+RMW) - Standard control	175.70	2.55	24.00	166.85	184.55	<.0001
Pm+Rmw+SD+CD	(Pm+Rmw+SD+CD) - Standard control	182.12	2.55	24.00	173.28	190.97	<.0001
PM+SD	(PM+SD) - Standard control	161.17	2.55	24.00	152.32	170.02	<.0001
Rmw+SD	(Rmw+SD) - Standard control	155.26	2.55	24.00	146.41	164.10	<.0001

Table 4

Treatment	Means	
Absolute control	270.1886	e
CD+PM	476.5089	a
CD+Rmw	467.1398	a
CD+SD	444.8957	c
PM+RMW	449.0128	bc
Pm+Rmw+SD+CD	455.4349	b
PM+SD	434.4819	d
Rmw+SD	428.5657	d
HSD	9.490309	

Table 5: Chemical composition of manure used

MANURE	N (%)	P (mg/kg)	K (Cmol/kg)	OC %	OM (%)	Na (Cmol/kg)
CD	3.36	7.5	1.205	6.30	23.94	0.725
PM	2.87	19.0	1.295	7.40	28.12	2.300
RMW	1.33	5.8	0.15	8.60	32.68	1.025
SD	0.56	2.0	0.08	8.4	31.92	12.700

Effect of soil amended with cow dung and sawdust on the 6–gingerol content of Ginger: The 6 – gingerol content of seed ginger extract was quantified and qualitatively evaluated using the reverse phase HPLC–UV method with gradient elution.

Table 6: Concentration of 6-gingerol of ginger harvested from soil amended with cowdung and sawdust @ 50% each

Treatment	Rep 1 Ug/ml	Rep 2 Ug/ml	Rep 3 Ug/ml	Mean Ug/ml
CD+SD(50%each)	444.8664	445.0719	444.7489	444.8956
N:P:K 15:15:15	273.4033	273.1302	273.1322	273.3122
Absolute control	269.7359	270.8640	269.9660	270.1886

The results indicated that ginger harvested from the soil amended with cowdung and saw dustat a rate of 50% each(i.e. 134g and 803.5g) per plot of 1m x 2m, which corresponds to the quantity required to supply 45 kg N per hectare, yielded a mean gingerol concentration of 444.8956 ug/ml. When compared to the standard control (N:P:K 15:15:15), it had a significant effect ($p<0.05$) on the 6 gingerol content. Additionally, it exhibited a statistically significant effect ($p<0.05$) when compared to the Absolute Control (No amendment material). Additionally, it was discovered that the gingerol content of ginger grown on soil modified with cowdung and sawdust at 50% each was not significantly different from that of ginger produced on soil amended with poultry manure and rice mill waste at 50% each..

Additionally, the findings of this study indicate that treatments or amendments that boost ginger crop production may not always convert into increased 6-gingerol yield, demonstrating that ginger yield is not directly proportional to 6-gingerol yield. The increase in 6-gingerol in organic fertilization using combination of cow dung and saw dust could be attributed to the presence of other major and minor elements in cow dung and saw dust that are not present in fertilizer, such as organic carbon, organic matter (composed primarily of approximately 55-57 percent carbon, 35-45 percent hydrogen, and 3-5 percent oxygen), phenylalanine, glutamic acid, hydroxyproline, methionine, tyrosine, and leucine. This could improve food accessibility and physiological processes that support metabolic pathways such as those that generate 6-gingerol.

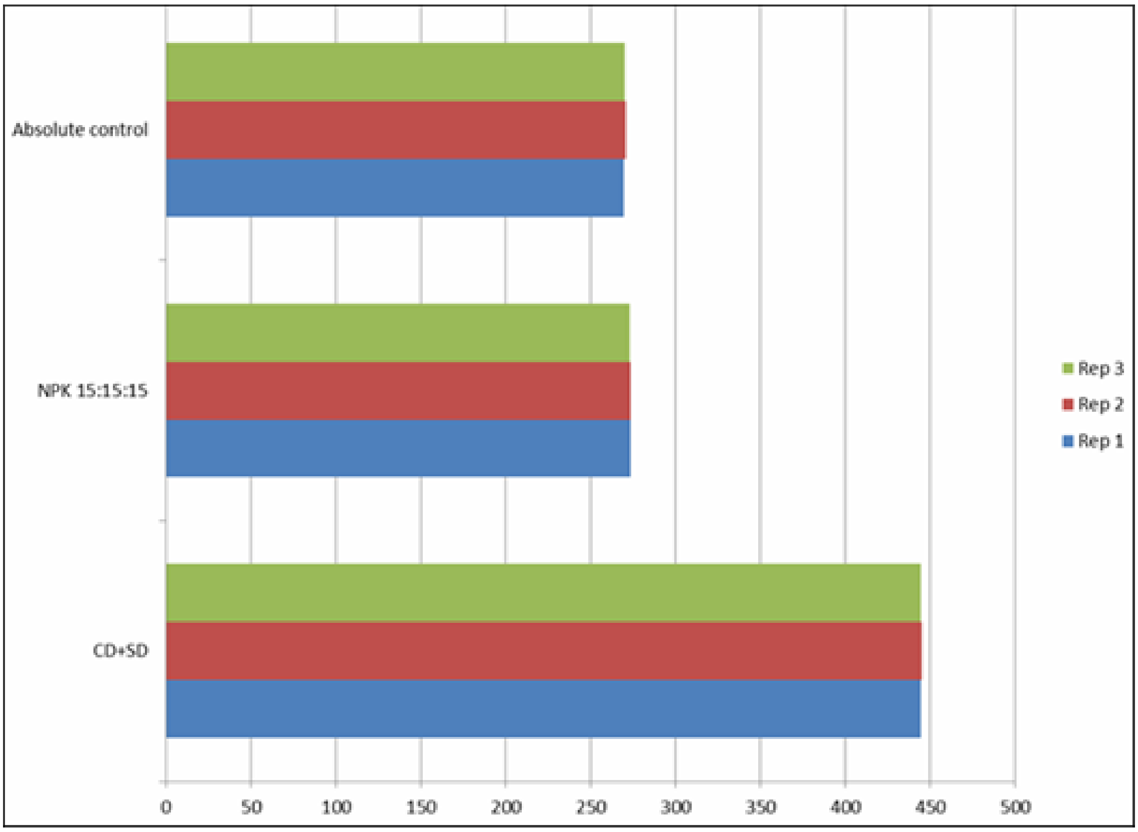


Fig 2: Bar graph indicating the 6-gingerol concentration of ginger collected from soil amended cowdung and sawdust at 50% each.

Effect of soil amended with a combination of cow dung and poultry manure (50% each) on the 6–Gingerol content of Ginger

The reverse phase HPLC–UV technique with gradient elution was used to quantify and qualitatively evaluate the 7– Gingerol content of seed ginger extract.

Table 7: Concentration of 6-gingerol of ginger harvested from soil amended with cowdung and poultry manure @ 50 each

Treatment	Rep 1 Ug/ml	Rep 2 Ug/ml	Rep 3 Ug/ml	Mean Ug/ml
CD+PM (50%each)	472.5540	476.0136	480.9591	476.5089
Standardcontrol (N:P:K 15:15:15)	273.4033	273.1302	273.1322	273.3122
Absolute control	269.7359	270.8640	269.9660	270.1886

The results showed that ginger obtained from soil supplemented with cowdung and poultry manure at 50% each (134g and 157g) per plot of 1m x 2m, which corresponds to the quantity required to deliver 45 kg N per hectare, ie 22.5kg N each, gave a mean 6-gingerol concentration of 476.5089 ug/ml. It had a significant influence ($p<0.05$) on the 6 gingerol content when compared to the normal control (N:P:K 15:15:15). Furthermore, when compared to the Absolute Control, it had a statistically significant effect ($p<0.05$) (No amendment material). Furthermore, it was revealed that the gingerol content of ginger grown on soil amended with 50% cowdung and 50% poultry manure was not substantially different from ginger cultivated on soil amended with 50% cow dung and 50% rice mill waste. There was also no significant difference in the gingerol content of ginger grown on soil amended with cowdung and poultry manure at 50% each and that of ginger cultivated on soil amended with poultry manure. Furthermore, the results of this study show that treatments or amendments that increase ginger crop output do not always result in greater 6-gingerol yield, suggesting that ginger yield is not directly proportional to 6-gingerol yield. The presence of other major and minor elements in cow dung and saw dust that are not present in fertilizer, such as organic carbon, organic matter (composed primarily of approximately 55-57 percent carbon, 35-45 percent hydrogen, and 3-5 percent oxygen), phenylalanine, glutamic acid, hydroxyproline, methionine, tyrosine, and leucine, could explain the increase in 6-gingerol in organic fertilization using a combination of cow dung and saw dust.

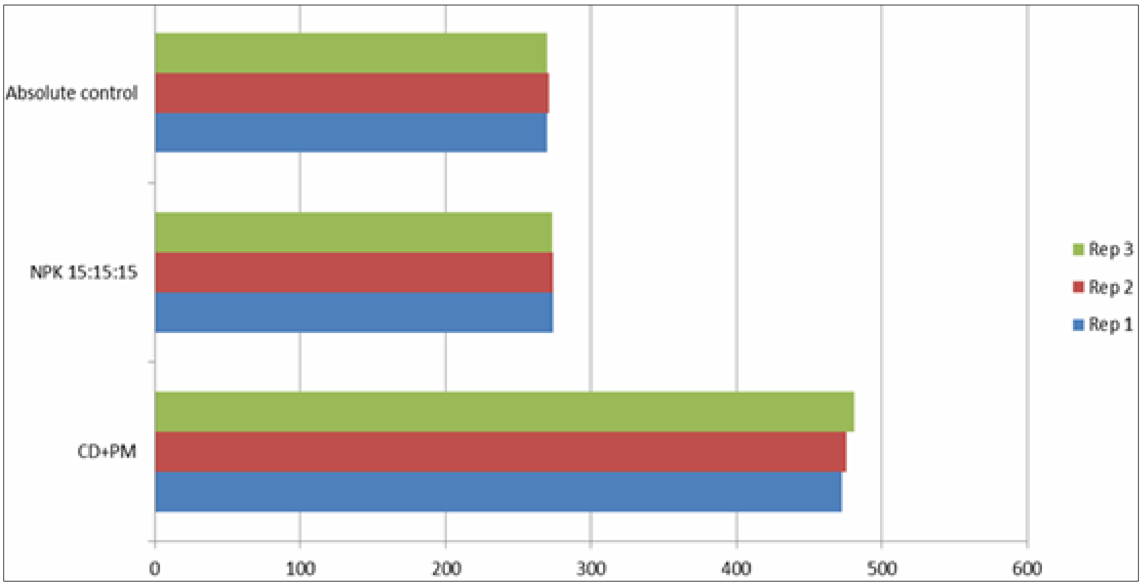


Fig 3: Bar graph for 6-gingerol content of ginger harvested from soil amended with cowdung and poultry manure at 50% each.

Effect of soil amended with poultry manure and Rice mill waste on the 6–gingerol content of Ginger. The quantity of 6 – gingerol in seed ginger extract harvested from soil amended with poultry manure and rice mill waste was quantified and qualitatively evaluated using the reverse phase HPLC–UV method with gradient elution.

Table 8: Concentration of 6-gingerol of ginger harvested from soil amended with poultry manure and rice mill waste @ 50 each

Treatment	Rep 1	Rep 2	Rep 3	Mean
PM+RMW (50%each)	452.9492	446.5108	447.5783	449.0128
Standard control (N:P:K	273.4033	273.1302	273.1322	273.3122
Absolute control	269.7359	270.8640	269.9660	270.1886

Ginger harvested from soil amended with poultry manure and rice mill waste at a rate of 50 percent each (157g and 338.5g) per plot of 1m x 2m, which corresponds to the quantity required to supply 45 kg N per hectare (ie 22.5kg N each), yielded a mean 6-gingerol concentration of 449.0128 ug/ml, according to the results of the study. Comparing the gingerol content of the 6 gingerol extract to that of the standard control (NPK 15:15:15), it had a statistically significant effect ($p<0.05$). Additionally, when compared to the Absolute Control, it had a statistically significant effect ($p<0.05$). Also revealed was that the 6-gingerol content of ginger cultivated on soil amended with poultry manure and rice mill waste at 50% each was not significantly different from that of ginger grown on soil treated with cow dung and sawdust at 50% each. The 6-gingerol content of ginger grown on soil amended with poultry manure and rice mill waste at 50 percent each did not differ significantly from that of ginger grown on soil amended with poultry manure +sawdust + rice mill waste + cowdung at 25 percent each. The findings of this study also suggest that treatments or amendments that increase ginger crop output may not always result in greater 6-gingerol yield, suggesting that ginger yield is not directly proportional to 6-gingerol yield.

The presence of other major and minor elements in cow dung and saw dust that are not present in fertilizer, such as organic carbon, organic matter (composed primarily of carbon, hydrogen, and oxygen), phenylalanine, glutamic acid, hydroxyproline, methionine, tyrosine, and leucine, could explain the increase in 6-gingerol in organic fertilization using a combination of poultry manure and rice mill waste.

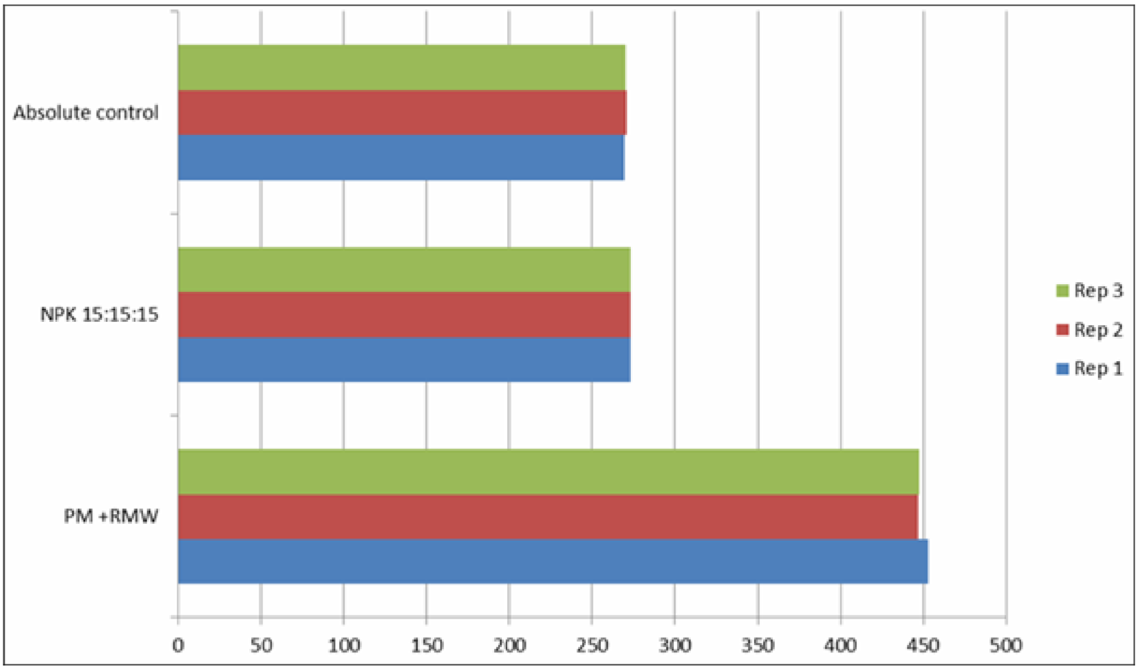


Fig 4: Bar graph for 6-gingerol content of ginger harvested from soil amended with poultry manure and rice mill waste at 50% each.

Effect of Soil Amended with Rice Mill Waste and Sawdust on the 6–Gingerol Content of Ginger.

Using the reverse phase HPLC–UV technique with gradient elution, the 6–gingerol content of seed ginger extract obtained from soil amended with 50% rice mill waste and 50% sawdust was measured and quantitatively evaluated.

Table 9: Concentration of 6-gingerol of ginger harvested from soil amended with Rice mill waste and sawdust @ 50% each

Treatment	Rep 1	Rep 2	Rep 3	Mean
RMW+SD (50%each)	432.61	425.34	427.73	428.56
Standard control	273.40	273.13	273.13	273.31
Absolute control	269.73	270.86	269.96	270.18

The results showed that ginger harvested from soil amended with rice mill waste and sawdust at a rate of 50% each (338.5g and 803.5g) per plot of 1m x 2m, corresponding to the quantity required to supply 45 kg N per hectare, ie 22.5kg N each, yielded a mean 6-gingerol concentration of 428.5657 ug/ml. It had a significant influence ($p<0.05$) on the 6 gingerol content when compared to the standard control (N:P:K 15:15:15). Furthermore, when compared to the Absolute Control, it had a statistically significant effect ($p<0.05$).. Furthermore, the 6-gingerol concentration of ginger grown on soil amended with rice mill waste and sawdust at 50% each was not substantially different from ginger cultivated on soil supplemented with rice mill waste. There was also no statistically significant difference between the 6-gingerol concentration of ginger cultivated on soil amended with rice mill waste and sawdust at 50% each and ginger grown on soil amended with poultry manure and sawdust at 50% each. Furthermore, the results of this study show that treatments or amendments that increase ginger crop output do not always result in greater 6-gingerol yield, suggesting that ginger yield is not directly proportional to 6-gingerol yield. The presence of other major and minor elements in rice mill waste and saw dust that are not present in NPK fertilizer, such as organic carbon, organic matter (composed primarily of carbon, hydrogen, and oxygen), phenylalanine, glutamic acid, hydroxyproline, methionine, tyrosine, and leucine, could explain the increase in 6-gingerol in organic fertilization using a combination of poultry manure and rice mill waste.

Effect of soil amended with poultry manure and sawdust on the 6–gingerol content of Ginger

Using the reverse phase HPLC–UV technique with gradient elution, the 6–gingerol content of seed ginger extract cultivated on soil modified with poultry manure and sawdust was measured and qualitatively evaluated.

Table 10: Concentration of 6-gingerol of ginger harvested from soil amended poultry manure and sawdust @ 50% each

Treatment	Rep 1 Ug/ml	Rep 2 Ug/ml	Rep 3 Ug/ml	Mean Ug/ml
PM+SD (50%each)	432.8720	433.5526	437.0210	434.4819
Standard control (N: P: K 15:15:15)	273.4033	273.1302	273.1322	273.3122
Absolute control	269.7359	270.8640	269.9660	270.1886

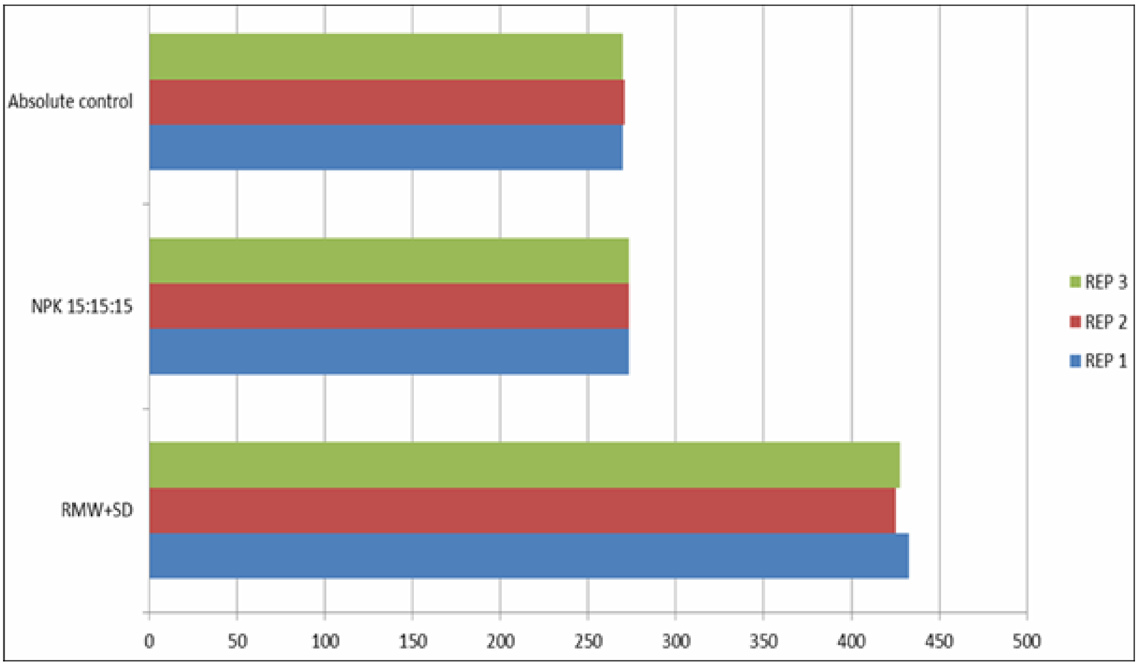


Fig 5: Bar graph for 6-gingerol content of ginger harvested from soil amended with rice mill waste and sawdust at 50% each.

A mean 6-gingerol concentration of 434.4819 ug/ml was obtained from ginger harvested from soil supplemented with poultry manure and sawdust at 50% each (157g and 803.5g) per 1m × 2m plot. Compared to the standard control (N: P: K 15:15:15), it had a significant effect ($p<0.05$). It also had a statistically significant influence ($p<0.05$) on the Absolute Control (No amendment material). The 6-gingerol content of ginger cultivated in soil amended with 50% poultry manure and 50% sawdust was not substantially different from ginger grown in soil treated with rice mill waste. The 6-gingerol concentration of ginger cultivated on soil amended with rice mill waste and sawdust at 50% did not differ from ginger grown on soil treated with poultry manure and sawdust at 50%. This study also found that treatments or amendments that enhance ginger crop yield may not always increase 6-gingerol yield, proving that ginger yield is not directly proportional to 6-gingerol yield. In rice mill waste and saw dust, there are other major and minor elements that are absent in NPK fertilizer, such as organic carbon, organic matter (composed primarily of carbon, hydrogen, and oxygen), phenylalanine, glutamic acid, and leucine.

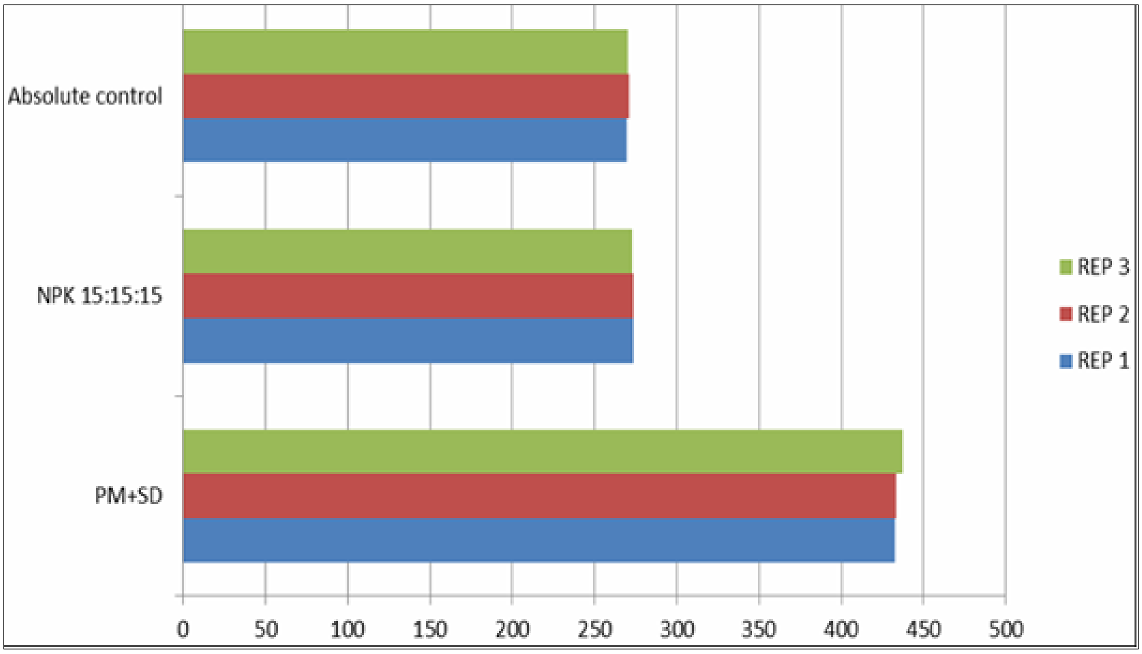


Fig 6: Bar graph for 6-gingerol content of ginger harvested from soil amended with poultry manure and sawdust at 50% each

Effect of soil amended with cow dung and Rice mill waste on the 6–gingerol content of Ginger

Utilizing the reverse phase HPLC–UV technique with gradient elution, the 6–gingerol concentration of seed ginger extract grown on soil treated with cow dung and rice mill waste at 50% each was measured and qualitatively assessed.

Table 11: Concentration of 6-gingerol of ginger harvested from soil amended with cow dung and Rice mill waste @ 50% each

Treatment	Rep 1 Ug/ml	Rep 2 Ug/ml	Rep 3 Ug/ml	Mean Ug/ml
CD+RMW (50%each)	470.9229	462.7813	467.7151	467.1398
Standard control (N:P:K 15:15:15)	273.4033	273.1302	273.1322	273.3122
Absolute control	269.7359	270.8640	269.9660	270.1886

Ginger harvested from soil amended with cow dung and rice mill waste at a rate of 50% each (i.e. 134g and 338.5g) per plot of 1m x 2m, which corresponds to the quantity required for 45 kg N per hectare, i.e. 22.5kg N each, yielded a mean 6-gingerol concentration of 467.1398 ug/ml, according to the findings. Comparing the gingerol content of the 6 gingerol extract to that of the standard control (NPK 15:15:15), it exhibited a statistically significant impact ($p<0.05$). Additionally, when compared to the Absolute Control, it had a statistically significant impact ($p<0.05$) (No amendment material). It was found that the 6-gingerol content of ginger cultivated on soil amended with cowdung and rice mill waste at 50% each was not substantially different from the 6-gingerol content of ginger grown on soil supplemented with poultry manure. The 6-gingerol content of ginger cultivated on soil amended with cow dung and rice mill waste at 50 percent each did not vary significantly from the 6-gingerol content of ginger grown on soil treated with cow dung and poultry manure at 50 percent each. Organic fertilization using a combination of cowdung and rice mill waste resulted in an increase in 6-gingerol levels, which could be attributed to the presence of other major and minor elements in rice mill waste and cowdung that are not present in NPK fertilizer, such as organic carbon, organic matter (which is composed primarily of carbon, hydrogen, and oxygen) amd phenylalanine.

Effect of soil amended with poultry manure, Rice mill waste, Sawdust and cow dung on the 6–gingerol content of Ginger

The reverse phase HPLC–UV technique with gradient elution was used to quantify and qualitatively assess the 6–gingerol content of seed ginger extract cultivated from soil amended with poultry manure.rice mill waste.sawdust and cowdung at 25%each.

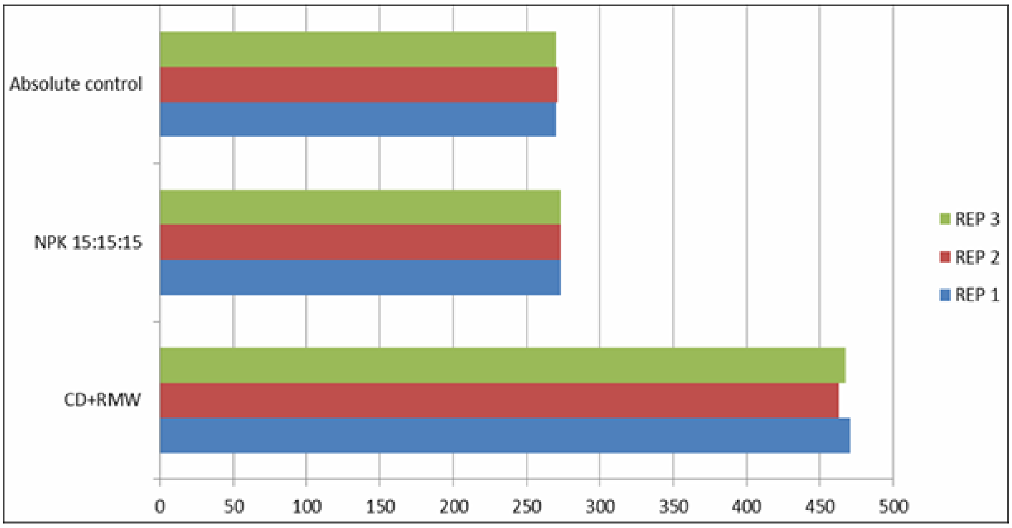


Fig 7: Bar graph for 6-gingerol content of ginger harvested from soil amended with cowdung and rice mill waste at 50% each

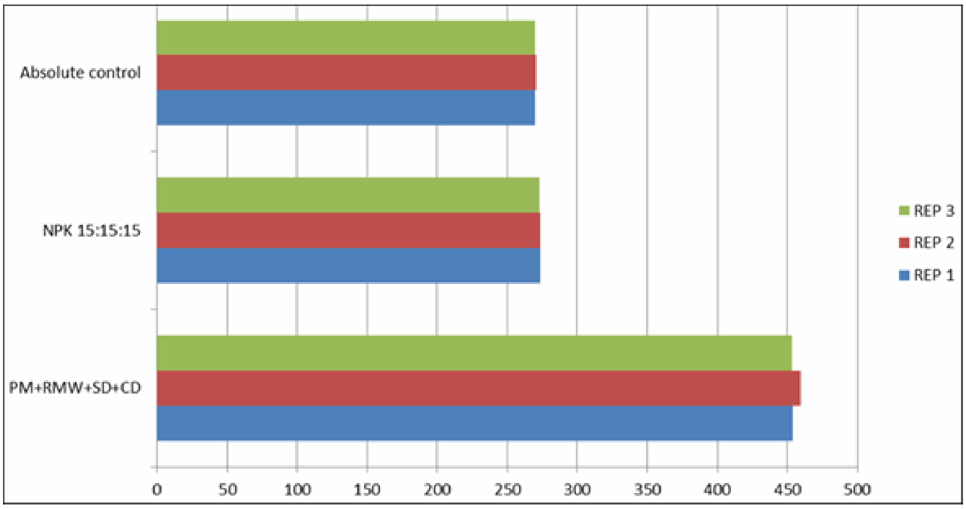


Fig 8: Bar graph for 6-gingerol content of ginger harvested from soil amended with poultry manure + rice mill waste, + sawdust+ cow dung at 25% each.

Table 12: Concentration of 6-gingerol of ginger harvested from soil amended with Poultry manure + Rice mill waste + Saw dust + Cow dung at 25% each

Treatment	Rep 1	Rep 2	Rep 3	Mean
	Ug/ml	Ug/ml	Ug/ml	Ug/ml
PM+RMW+SD+CD(25%each)	453.9085	459.3947	453.0015	455.4349
Standardcontrol(N:P:K 15:15:15)	273.4033	273.1302	273.1322	273.3122
Absolute control	269.7359	270.8640	269.9660	270.1886

The results showed that ginger harvested from soil amended with cow dung + rice mill waste + poultry manure + sawdust at a rate of 25 percent each (i.e. 67g, 169.25g, 78.5g, and 401.75g respectively) per plot of 1m x 2m, which corresponds to the quantity required to supply 45 kg N per hectare, i.e. 11.25kg N each, yielded a mean 6- gingerol concentration of 455.4349 Comparing the gingerol content of the 6 gingerol extract to that of the standard control (NPK 15:15:15), it exhibited a statistically significant impact ($p<0.05$). Additionally, when compared to the Absolute Control, it had a statistically significant impact ($p<0.05$). Ginger grown on soil amended with cowdung+ rice mill waste + sawdust+ poultry manure at a rate of 25 percent each did not have a statistically significant difference in 6-gingerol content from ginger grown on soil amended with poultry manure and rice mill waste at a rate of 50 percent each, according to the findings. The results of this research also suggest that treatments or amendments that enhance ginger crop output may not necessarily result in higher 6-gingerol yield, showing that ginger yield is not directly proportional to 6-gingerol yield. Organic fertilization using a combination of cowdung + rice mill waste + poultry manure + sawdust at a rate of 25 percent each could result in an increase in 6-gingerol due to the presence of other major and minor elements in the organic fertilizer that are not present in NPK fertilizer, such as organic carbon, organic matter (composed primarily of carbon, hydrogen, and oxygen), phenylalanine, glutamic acid, hydroxyproline, methionine, tyrosine,

Conclusion

The organic manures combinations used in this study significantly affected the 6-gingerol concentration of ginger but at different degrees. Cow dung + Poultry manure at 50% each has the most significant effect when

Compared with the other organic combinations used in this experiment though all the other combinations of organic manures used had significant effect ($p<0.05$) when compared with the Absolute control and Standard control. There was no significant difference between the effect of poultry manure + rice mill waste and poultry manure + rice mill waste + sawdust + cow dung. There was also no significant difference between the effect of Cow dung + sawdust and poultry manure + rice mill waste. The result equally showed no significant difference between the effects of poultry manure + saw dust and rice mill waste + saw dust. Different Organic manures combinations affected the 6-gingerol content of ginger at different degrees. The result of this research showed that the soil/plot amended with the combination of 134g of cow dung and 157g of poultry manure at 50% each per plot of 2m yielded the highest concentration of 6-gingerol among the organic manure combinations and is therefore recommended.

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