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Quality Assessment of Commercially Produced Composts in Saudi Arabia Market

Ahmad I. Al-Turki
Department of Plant Production and Protection,
College of Agriculture and Veterinary Medicine, Qassim University,
P.O. Box 6622, Buraidah 51452, Al-Qassim, Saudi Arabia

Abstract: A variety of stability and maturity indices were evaluated for 14 commercially produced composts in Saudi Arabia in order to acquire a comprehensive image of local compost quality and its compliance with local and international compost standards. Theses indices include chemical parameters such as Electrical Conductivity (EC), ammonium and nitrate concentrations, heavy metals and biological parameters such as Germination Index (GI), pathogen indicator and selected pathogens. Other important compost characteristics were also analyzed. Results revealed wide variations among samples in respect to all parameters examined. About 64% of tested compost exceeded the upper limit of EC set by most compost associations. The C/N ratio for compost samples ranged from 10.90 to 39.30 and 36% of samples were above the maximum value (1:25) set by various compost nations. Ten compost samples (71%) exceeded the maximum value set for nitrification index (NH_4/NO_3 ratio). Heavy metal contents in almost all compost samples were lower than the permissible levels set by local and international standards. GI test indicated that 64% of examined samples were below 80% and therefore could exhibit phytotoxicity. Microbiological analysis showed that 5, 4 and 10 compost samples were contaminated with faecal coliform, Salmonella and Staphylococci, respectively at levels above the suggested limit proposed by regulatory agency. Stability and maturity indices tested in this study have shown that most compost samples had a poor quality and should have no access to the market. The high variability of most important parameters of local composts suggests an urgent need for developing local compost quality standards in order to assure a good quality for land application, environment and public health.

Key words: Compost, germination index, heavy metals, pathogens, nitrification index

INTRODUCTION

Compost is the end product of the aerobic microbial decomposition of organic matter, such as animal manures, plant residuals and demotic wastes, under controlled conditions (Sullivan and Miller, 2001). Compost quality is a general terms describing the degree of compost stability and maturity. Stability is often related to microbial activity and refers to the resistance of compost organic matter to further degradation, whereas maturity is usually associated with plant growth potential or phytotoxicity and describes the fitness of compost for land application (Sullivan and Miller, 2001; Bernal *et al*., 2008). Many tests have been proposed for assessment of compost stability and maturity and they focus on physical,

chemical and biological properties of the compost. The most common properties include particle size distribution, moisture content, pH, salinity, organic matter, heavy metals content, evolved CO_2, germination index and the presence of pathogens (Rynk, 1992; Cooperband and Middleton, 1996; Changa *et al*., 2003; Wang *et al*., 2004; Lasaridi *et al*., 2006; Nicholson *et al*., 2005).

Land application of composted animal manures can be one of the most economical and attractive methods to solve two problems: waste disposal and the necessity to increase the organic matter content of soil (Giusquani *et al*., 1988; Changa *et al*., 2003; Bernal *et al*., 2008). Composts have been shown to enhance soil fertility and quality and to improve crop productivity. However, application of unstable or immature composts may have adverse effect on plant growth and environment and public heath (Chukwujindu *et al*., 2006; Bernal *et al*., 1998, 2008). Several official and private organizations in different countries have established standards and specifications for compost quality to improve crop production and to protect public health and environment (De Bertoldi, 1993; AS99, 1999; Brinton, 2000). Examples of fairly developed compost standards are those produced by California Compost Quality Council (CCQC, 2002) and British Standards, PAS-100-2005 (BSI, 2005).

In spite of the wide variations among the limit values and the number of tested parameters required by compost organizations, all national compost standards have given special considerations to compost properties associated with the public health and environment contamination such as heavy metals, pathogens and potentially toxic organic compounds (Brinton, 2000; Hogg *et al*., 2002).

In Saudi Arabia, several large feedlots are composting their manure for the agricultural market. These compost facilities engage a range of technologies, from simple static piles to automated in-vessel systems. Composts are then packed in a 25-50 L bags and sold in the market to farmers for land application. Some bags are labeled with facility information and the others have no label. Some big farms also manufacture compost by primitive methods and sell the product in unlabeled bags and is used widely by farmers as plant fertilizer. Recently, the Gulf countries established the law of organic fertilizers, which propose some specifications and regulations for compost quality (GCST, 2006). However, several important compost maturity indices such as germination index, nitrification index and compost respiration rate are not specified in GCST. Moreover, there are neither mechanisms nor organizations responsible for the evaluating the compost quality in Saudi Arabia, which may result in low quality that are harmful to public heath, plant and environment. To my knowledge, no report has been conducted concerning the quality assessment of the compost produced in Saudi Arabia. Accordingly, little information is available about maturity and stability indices of local composts.

The objective of the present study was to identify some physical, chemical and biological characteristics of compost produced in Saudi Arabia and derive their quality profile to examine their compliance with local and international compost standards such as CCQC (2002) and PAS100-2005.

MATERIALS AND METHODS

Preparation of Compost Samples

A total of 14 commercial composts produced in Saudi Arabia were obtained during summer of 2007 from the market through field research in bags of 25-50 L. They were identified, registered and a code system was used instead of brand names to ensure confidentiality (Table 1). Composts were immediately brought to the laboratory of soil

Table 1: Description of composts collected from Qassim markets used in this study

Compost code	Description
Ch1, Ch2	Chicken manure
Co3, Co4, Co5, Co6	Cow manure
Sh7, Sh8	Sheep manure
Pi9, Pi10	Pigeon manure
Pea11, Pea12	Various peat product marketed as a compost
Cam13	Camel manure
Mix14	Cow manure mixed with plant origin material

analysis at College of Agriculture and Veterinary Medicine, Qassim University and stored at 4°C to be analyzed within 24 h.

Chemical Properties

Each compost sample was mixed thoroughly to insure maximum homogeneity prior analysis. Moisture content in compost samples was determined through the weight loss at 80°C. Organic matter (OM) content was calculated from loss on ignition at 550°C for 8 h. Electrical conductivity (EC) and the pH values were determined in 1:5 water extract with a Hanna Digital Compo Meter (HI991405, Hanna, UK) according to TMECC method 04.10 1:5 Slurry (TMECC, 2002). Total organic carbon was determined using dichromate oxidation (Walkley and Black method) and then total organic matter was calculated as described by Nelson and Sommers (1996). Total N was determined using the macro-Kjeldahl distillation method (TMECC, 2002). Ammonium-N and nitrate-N were determined using micro-Kjeldahl distillation method. Heavy metals (Pb, Ni, Zn, Cd and Cu) were determined after digestion of 1 g (dw) of pulverized sample with pure nitric acid, using AAS (Shimazu 6800 Atomic Absorption Spectrophotometer) (Sposito *et al*., 1983).

Biological and Microbial Properties

Phytotoxicity, a parameter partly related to stability, was calculated as the Germination Index (GI) of *Lepidium sativum* seeds (Agrocementi Ltd., Athens), using a modified version of the method proposed by Zucconi *et al*. (1985). Twenty five seeds were placed on five layers of filter paper pads wetted with 5 mL of 1:10 compost aqueous extract in petri dishes incubated in the dark at 25°C for 48 h. Tap water was used as control. The total length of each cress root was measured. If the seeds did not germinate, their root length was considered to be 0 mm. the germination index is given as a percentage based on the total length of roots on the test plates multiplied by 100 and divided by total length of roots on the control plates.

Preparation of compost for microbiological analyses was performed as recommended by Sikora *et al*. (1983). A portion (50 g) of the compost was dispersed in 950 mL of sterile distilled water. They were then submitted to a mechanical shaking for 2 h. The resulting solid-liquid suspension was used for microbiological analyses. The total indigenous culturable mesopehlic bacteria in the suspension were determined by the plate pouring technique on nutrient agar. The plates were incubated at 30°C for three days. Most Probable Number (MPN) technique was employed to determine faecal coliforms using lauryl tryptose broth (LTB) (Difco, Sparks, MD) inoculated with the liquid suspension sample solution and incubated for 24 h at 35°C. The presence of faecal coliform was then confirmed by observing gas and acid formation in Enteric Coliform (EC) broth (Difco), which was incubated on the following day for 24 h at 44.5°C.

Staphylococcus was enumerated on Baird-Parker agar supplemented with egg yolk enrichment at 37°C for 48 h according to Hassen *et al*. (2001). Black shiny colonies

surrounded by hello zone were purified on Brain-Heart infusion agar (Pasteur Production, Paris) and examined microscopically. The presence of *Salmonella* sp., was determined as described by Andrews and Jacobson (2001). A portion of 25 mL of compost was pre-enriched in 225 mL of buffered peptone water at 37°C for 24 h. Then, 1 mL of pre-enrichment sample was incubated in 10 mL cystine selenite broth and Rappaport-Vassiliadis broth at 37°C for 24 h. Selective enrichments were then streaked onto bismuth sulphite, Xylose Lysine Desoxycholate (XLD) and Hekton entreic agars. All selective media were incubated at 37°C for 24 h. Typical colonies were examined by light microscope, characteristics of growth on lysine iron agar, negative of urease production and then tested with *Salmonella* polyvalent O antiserum (Salmonella latex test, Oxoid FT0203). Isolates with typical reactions for *Salmonella* were then confirmed by using API 20E identification kit (BioMérieux, France). Unless otherwise stated, all the media and supplements used throughout the present study were purchased from Oxoid (Oxoid, Basingstoke, Hampshire, England).

RESULTS AND DISCUSSION

Moisture contents, pH and EC of composts examined in this study are shown in Table 2. Moisture contents varied from 0.06% for the chicken manure compost (CH2) to 8.57 for the beat-based product (Pea11). All compost samples contained moisture less than the upper limit set by Gulf Counties St, British St and US St which ranged between 20 and 40% (Brinton, 2000; GCST, 2006; BSI, 2005). The upper limit of moisture content in compost is set to prevent odor problems and the development of anaerobic conditions during storage (Lasaridi *et al*., 2006). High moisture content in compost will be confusing or misleading for consumers, especially when materials are marketed on weight basis.

All compost samples exhibited almost neutral to alkaline with pH values ranging from 6.75 to 9.42 (Table 2). GCST requires that pH of compost should not exceed 7.5 which was not met by 64% of examined samples. Other national standards suggest pH values between 6 and 8.5 (CCQC, 2002; BSI, 2005) which was met by 64% of compost samples. Although pH cannot be considered a good parameter to assess compost maturity as its overall trend is not described by a monotonic function (Chukwujindu *et al*., 2006), its values should be in the range that insure compatibility with most plants (Hogg *et al*., 2002).

Considerable variations were observed in the electrical conductivity (EC) of compost samples which varied from 1.32 to 39.61 dS m^{-1} (Table 2). Only four samples (30%) exceeded the maximum level set by GCST for EC (10 dS m^{-1}). However, the maximum level of compost

Table 2: Moisture content, pH, electric conductivity and bulk density in 14 samples of examined composts

Compost*	Moisture content (%)	pH	EC (dS m^{-1})
Ch1	4.88	6.88	18.14
Ch2	0.06	7.92	11.95
Co3	3.96	8.79	8.53
Co4	1.22	8.41	3.34
Co5	0.74	8.42	8.73
Co6	1.78	7.67	2.84
Sh7	2.11	8.62	3.83
Sh8	0.35	9.42	1.23
Pi9	4.06	7.21	11.80
Pi10	1.28	7.23	2.80
Pea11	8.57	7.21	6.02
Pea12	1.73	6.75	39.61
Cam13	2.60	9.41	5.08
Mix14	4.03	8.86	7.98
SD	2.27	0.91	9.83

*Abbreviations of composts are explained in Table 1

Table 3: Total N, organic matter, organic C, ammonium-N, nitrate-N and C/N ratio in 14 samples of examined composts

Compost*	Total N (%)	Organic matter (%)	Organic C (%)	NH_4^+-N (mg kg^{-1})	NO_3^--N (mg kg^{-1})
Ch1	1.08	55.77	30.10	3069	431.00
Ch2	1.65	32.85	19.10	2996	196 .00
Co3	1.21	35.95	20.90	421	32.50
Co4	0.25	11.70	6.83	308	56.00
Co5	0.87	20.31	11.81	112	57.00
Co6	0.62	27.04	15.72	201	722.40
Sh7	0.57	22.88	13.30	392	89.60
Sh8	0.11	5.61	3.26	56	44.80
Pi9	1.26	65.86	38.29	1097	285.60
Pi10	0.70	17.66	10.27	548	78.40
Pea11	1.26	23.63	13.74	560	420.00
Pea12	1.33	28.45	16.54	27944	672.00
Cam13	1.03	69.63	40.48	123	5.60
Mix14	1.13	27.00	15.70	358	67.20
SD	0.44	18.87	1.97	7325.17	243.59

*Abbreviations of composts are explained in Table 1

EC recommended by PAS 100-2005 and CCQC is 4 dS m^{-1} which was surpassed by 64% of compost samples. Acceptable levels of compost EC should be determined on the basis of the intended use of compost. When compost is used as a growth medium, EC level should not exceed 2.5 dS m^{-1} to avoid reduction in plant germination and growth (Dimambro *et al*., 2007). For instance, when compost with EC of 5.3 dS m^{-1} was used a growth medium, germination of lettuce and cabbage was inhibited (Brito, 1999). EC level of 9 dS m^{-1} was found to be detrimental to tomato seedling emergence and developments (Castillo *et al*., 2004). The EC decision on the eco-label award sets an upper EC limit of 1.5 dS m^{-1} for compost used as a growing media (EC, 2001), which was met by only one sample of composts studied (7%). When compost is used as soil amendments, accepted EC level will depend on soil properties, amount of applied compost and type of plant. Nevertheless, usage of compost as soil amendments with such high EC may result in salt accumulation in soil which can cause toxicity to plants. It seems that a level of 4 dS m^{-1} should be chosen as a maximum limit for compost EC and accordingly only 5 of 14 compost samples met this limit.

Total nitrogen contents in compost samples ranged between 0.11 and 1.65% (Table 3). The wide variations in total N content are usually attributed to the quantity of protein in the original raw materials used for manufacturing compotes. Materials with high protein, e.g., poultry manure, should result in higher nitrogen contents, while low protein contents, e.g., straw, should result in composts with low nitrogen content. Percentage organic matter (OM) varied widely from 5.61 to 69.36% (Table 3). Only four samples (29%) contained more than 40% OM, the minimum percentage recommended by GCST and seven samples contained more that 25% OM, the minimum percentage recommended by CCQC (2002).

Organic carbon contents in compost samples were between 3.26 and 40.48% (Table 3). In general, organic carbon contents decrease during composting process and hence, low contents may indicate further decomposition (Brewer and Sullivan, 2003).

Results have shown considerable variations in ammonium-N (NH_4^+-N) and nitrate-N (NO_3^--N) concentrations in compost samples (Table 3). The NH_4^+-N concentrations were 112 to 27944 mg kg^{-1}, whereas NO_3^--N concentrations were 5.60 to 722.4 mg kg^{-1}. According to CCQC (2002), mature compost should contain NH_4^+ less than 500 mgKg-^{1} which was not met by 43% of compost samples. Three compost samples (Ch1, Ch2 and Pea12) contained NH_4^+ several folds above CCQC limit and may cause toxicity to plant germination. Pea12 sample, in particular, is suspected to be mixed with mineral ammonium fertilizers. Most national standards did not provide limits for nitrate concentration in compost except PAS 100-2005 which requires that compost should contain between 15 and 120 mg kg^{-1} NO_3^-N and this was achieved by 57% of compost samples.

Table 4: Nitrification index, CO2 evolution, and germination index in 14 samples of examined composts

Compost*	C/N ratio	NH_4^+/NO_3^- ratio	GI (%)
Ch1	27.87	7.12	0.00
Ch2	11.58	15.29	70.00
Co3	17.27	12.95	55.00
Co4	27.32	5.50	85.00
Co5	13.57	1.96	70.00
Co6	25.35	0.28	85.00
Sh7	23.33	4.38	75.00
Sh8	29.64	1.25	156.00
Pi9	30.39	3.84	0.00
Pi10	14.67	6.99	75.00
Pea11	10.90	1.33	70.00
Pea12	12.44	41.58	0.00
Cam13	39.30	21.96	55.00
Mix14	13.80	5.33	85.00
SD	9.01	11.56	39.06

*Abbreviations of composts are explained in Table 1

Although, nitrogen and organic contents *per se* are not considered viable indicators for compost stability or maturity, carbon to nitrogen (C/N) ratio in compost has been proposed as a good indication of compost maturity (Brinton, 2000; Chukwujindu *et al*., 2006). Several studies reported a decrease in C/N ratio during composting to the range of 20:1 to 11:1 in the final products (Brewer and Sullivan, 2003; Ko *et al*., 2008). It is found that composts having C:N less than 20 would prevent nutrient immobilization or N starvation in the soil (Brinton, 2000; Chukwujindu *et al*., 2006). Accordingly, GCST, PAS100-2005 and CCQC St require that C/N ratio to be less than or equal to 25. Moreover, CCQC requires that compost must meet this limit prior to any tests of maturity index (CCQC, 2002). In the present study, C/N ratio in compost samples ranged between 10.90 to 39.30 (Table 4) and 36 % of samples exhibited C/N above 20.

Nitrification index (NH_4^+/NO_3-ratio) has been proposed as criterion for assessing compost maturity (Brewer and Sullivan, 2003; Ko *et al*., 2008). The NH_4^+/NO_3-ratio, in favor of oxidized form, is considered desirable for mature compost. During composting processing, NH_4^+/NO_3-ratio should decrease to reach a value equal or less than 3, the limit set by CCQC (2002). As shown in Table 4, NH_4/NO_3 ratio ranged between 0.28 and 41.58, with only 30% of compost samples falling well below the value of 3. Moreover, NH_4^+/NO_3-ratios for eight samples (57%) were between 5.33 and 41.58 (Table 4) which clearly indicated the immaturity of these samples and hence the usage of them as organic fertilizer will pose negative impact on plant germination and growth.

Germination index (GI) is commonly used to evaluate the phytotoxicity of compost, which is attributed to various parameters such as salinity, ammonia volatilization and/or molecular weight organic compounds (Tam and Tiquia, 1994; Brinton, 2000). The presence of toxic compounds is perhaps the most serious problem associated with the utilization of immature composts which may inhibit seed germination (Bernal *et al*., 2008). The GI values of compost varied from 0 to 156% (Table 4). Zucconi *et al*. (1985) reported that compost with germination index value greater than 80% was phytotoxin-free. Only three compost samples (21%) exhibited a GI above 80%. CCQC (2002) classified composts according to the GI values into three classes: very mature (GI >90%), mature (GI 80-90%) and immature (GI <80). According to these limits, only one sample (7%) was very mature, two samples (14%) were mature and 11 samples (79%) were immature and could exhibit phytotoxicity. Several studies reported negative impact of compost with GI lower than 80% on seed emergence and plant growth when applied to agricultural land (Zucconi *et al*., 1985; Dimambro *et al*., 2007; Bernal *et al*., 2008).

Table 5: Selected heavy metal contents in 14 samples of examined composts

Compost*	Zn	Cu	Pb	Co	Ni	Cd
	(mg kg^{-1})					
Ch1	178.00	126.2	3.95	2.35	7.10	0.70
Ch2	176.00	45.4	2.36	4.98	13.40	0.84
Co3	153.00	40.2	6.42	3.72	17.30	1.00
Co4	27.00	5.7	3.42	2.96	13.90	0.24
Co5	196.00	39.8	11.19	6.33	12.90	2.10
Co6	143.00	13.3	18.44	6.10	13.30	1.13
Sh7	33.00	8.5	1.94	1.86	13.70	0.19
Sh8	10.00	2.40	1.47	4.63	8.80	0.77
Pi9	58.00	16.70	5.01	3.28	19.20	0.05
Pi10	89.00	4.90	3.36	0.94	4.30	0.70
Pea11	86.00	21.30	23.51	10.79	28.00	0.84
Pea12	100.00	9.70	26.34	12.10	48.10	10.52
Cam13	102.00	13.30	6.54	2.30	6.00	1.13
Mix14	96.00	8.3	6.66	2.30	8.90	0.93
SD	59.22	32.27	8.21	3.30	11.20	2.64

*Abbreviations of composts are explained in Table 1

Generally, some contaminants such as ammonia and phenol disappear during composting process, but heavy metals tend to remain in the end product which constitutes a very important problem from an agricultural and environmental standpoint (Ko *et al*., 2008). It is essential, therefore, to evaluate heavy metals contents in composts prepared for land application. The concentrations of selected heavy metals (Zn, Cu, Pb, Co, Ni,, Cd) in 14 compost samples are shown in Table 5. The maximum permissible concentrations required by GCST, CCQC and PA 100-2005 for Zn, Cu,, Pb, Co, Ni and Cd in compost are 350, 150, 50, 120, 25 and 3 mg kg^{-1}, respectively. Heavy metal contents in all compost samples were lower than limits set by national standards of compost with exception of Cd in only one sample (Pea12) which contained 10.52 mg kg^{-1}(Table 5). However, more frequent monitoring for heavy metals contents in compost are necessary since they can accumulate in soil due to repeated application of the animal manure compost and may be absorbed by plants and eventually enter the food chain.

The population of total mesophilic count ranged from 2×10^4 to 2.7×10^7 cfu g^{-1} in compost samples (Table 6). Microbial activity responsible for organic material biodegradation is mainly due to mesophilic bacteria community. High levels of aerobic bacterial (>10^8 cfu g^{-1}) in compost could be attributed to presence of easily biodegradable organic matter. However, number of mesophilic bacteria measured in this work was lower than those reported by Lasaridi *et al*. (2006) and Hassen *et al*. (2001) and equivalent to those found normally in fertile soils.

Faecal coliform bacteria are often used as an indicator of overall sanitary quality of composts. G CST requires the absence of faecal coliform bacteria in compost, whereas CCQC (2002) and PAS 100-2005 (BSI, 2005) require that faecal coliform to be less than 1000 cfu g^{-1} in compost. Faecal coliforms were detected in five compost samples which ranged from 3×10^3 in Cam13 to 8.5×10^5 in Pi9, indicating that 36% of compost samples exceeded the upper limit set for faecal coliforms. The presence of *Salmonella* is considered as a major problem of the hygienic quality of compost (Hassen *et al*., 2001). *Salmonella* is known to survive for long periods (up to 250 days) in soil amended with compost containing *Salmonella* as fertilizer (Jones, 1986). Turpin *et al*. (1993) reported that *Salmonella* may persist in soil for a longer period but in a viable non-culturable state and cannot be detected by traditional technique. As shown in Table 6, results revealed that 4 compost samples under study were contaminated with *Salmonella* with number ranged from 4 to 25 cfu g^{-1}. All compost regulations agencies required that *Salmonella* must be absent in compost intended for land

Table 6: Populations of total mesophilic count, faecal coliform, and *Salmonella* sp. and *Staphylococcus* sp. in 14 samples of examined composts

Compost*	Total mesophilic count	Faecal colifrom	*Salmonella*	*Staphylococci*
	(cfu g^{-1})			
Ch1	2.7×10^{7}	Absent	Absent	180
Ch2	6×10^{4}	Absent	Absent	4000
Co3	2.4×10^{6}	Absent	Absent	7000
Co4	8.3×10^{6}	5.6×10^{3}	4	2000
Co5	5×10^{4}	Absent	Absent	300
Co6	3×10^{4}	Absent	Absent	5
Sh7	3.5×10^{6}	Absent	8	7000
Sh8	2×10^{4}	Absent	Absent	Absent
Pi9	$10\times^{7}$	$8{,}9\times10^{4}$	Absent	10000
Pi10	1.2×10^{6}	3.4×10^{3}	25	2000
Pea11	5×10^{4}	Absent	11	Absent
Pea12	2×10^{4}	Absent	Absent	Absent
Cam13	8×10^{4}	3.4×10^{4}	Absent	500
Mi×14	2.2×10^{6}	1.6×10^{3}	Absent	Absent

*Abbreviations of composts are explained in Table 1

application (CCQC, 2002; BSI, 2005; GCST, 2006). *Staphylococcus* sp., seemed to be the dominant bacteria which were detected in 10 compost samples (71%) with numbers ranging between 5 and 10^4 cfu g^{-1} (Table 6). This result could be explained by the fact that *Staphylococci* are resistant to reduced water potential and tolerate drying and high salinity in the environment and thus can survive for long period (Termorshuizen *et al*., 2003). Moisture contents in most compost samples were very low and did not exceed 2.60 in 70% of samples (Table 2). It is worth mentioning that *Staphylococcus* can easily be transmitted with food consumption and the presence of the pathogenic species in composts used as a fertilizer may cause serious epidemiological problems (Lasaridi *et al*., 2006). Microbiological analysis in current study showed that 11 compost samples (79%) were contaminated either with faecal coliform, *Salmonella*, or *Staphylococcus* and accordingly these composts should have no access to the market and are not suitable for land application. The presence of theses microorganisms in compost samples may be attributed to insufficient heat required for pathogens destruction during the active phase of composting process.

CONCLUSION

Analysis of 14 locally manufactured composts revealed that most samples examined in this study failed to meet standards required for compost quality in particular those set for EC, C/N ratio, NH_4/NO_3 ratio, GI and the presence of pathogens. Heavy metals contents in compost samples were lower than maximum levels recommended by the regularity compost agency. Generally, most compost samples tested in this study had poor quality and are not recommended for soil fertilizer. Results indicated wide variations among composts examined in respect to all parameters tested, which suggest an urgent need for establishing quality assurance procedures to assure good quality for plant growth and public health and to increase the reliability of compost as end product of waste treatment. Moreover, a comprehensive local standard for compost quality is lacking and, thus, must be developed by authorities and scientists. Such standards should be based on local soil properties, risk assessment and plant types and growth.

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