Research Article

Characterization of Different Organic Wastes for Boron and Validation of Extraction Methods

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Abstract

Laboratory study was conducted to characterize the different organic wastes for boron content and to validate the suitability of B extraction methods. A range of locally available organic wastes namely farm yard manure, poultry manures, different crop residues and vermicompost were collected and B content was analyzed by wet digestion under closed condition and by dry ashing method. Under dry ashing method, B was extracted using 0.36N H_2SO_4 by allowing 1 hr time. The extracted B by different methods was determined by following the Azomethine-H method. Wet digestion with di acid was done in a closed system using digestion block. Results showed that 93-98 % B was recovered from the organic wastes under di acid digestion in a closed system when compared to dry ashing method. Higher recovery of boron was obtained in the cotton bur under di acid digestion (98.8 percent) followed by the sugarcane trash (93.8 percent). Higher recovery of B from plant parts was obtained when the wastes is rich in Ca content. Within the same extraction methods, the agro wastes of the same crop collected from different locations differ in their B content. Similarly the B content of vermicompost varied with the locations and lot. Hence detailed study is needed on these aspects to find out the influence of agro environmental practices on B content in different organic wastes.

Keywords: Boron, organic wastes, extraction methods, characterization, Azomethine-H, dry ashing method, di acid digestion

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Introduction

Intensive agriculture has been successfully practiced by many farmers through balanced fertilization using required cationic micronutrients specific to the crops. However boron (B) deficiency is the most commonly occurring problem in intensively cropped areas as well as in the farm where organic farming is practiced which is very significant and is likely to become more prevalent in future. To overcome its deficiency the requirement of the crop is satisfied with the application of B fertilizers, but it have short term effect as its availability in soil is reduced because of their greater leaching potential especially in sandy soils and under high rainfall situations [1]. Further its deficiency can be a problem on soils containing insufficient B, or when B availability to the plant is reduced as B changes form with higher soil pH [2]. The supply of B through organic sources will benefit the crop in long run, since most of the available B in soils is found to be in the soil organic matter fraction with best correlation [3]. The identification of organic sources which are rich in B may also help the farmers who have been practicing organic farming. A number of methods are available for the extraction of B from soil, water and plant [4] and were validated mostly for soil and water. However, the method of B extraction from organic manures along with other nutrients was not yet validated. The available validated methods like ICP-AES, MP-AES and FAAS [5-9] also highly sophisticated and needs huge investments. Hence, the present study was undertaken to characterize the locally available different organic sources for B content and also to validate the suitability of different B extraction methods from various wastes.

Materials and Methods

A range of locally available organic wastes namely farm yard manure, poultry manures, different crop residues viz., cotton bur and stalks, corn leaves and cob wastes, turmeric and onion leaves after harvest, banana sheath, coir wastes, ground nut husk, sunflower stalks, mango & banana fruit skin, vermicompost prepared from different wastes and other locally available vegetable wastes from market were collected. The B content in each waste was extracted by different methods viz., wet digestion under closed condition using diacid and triacid separately and dry ashing method. Under dry ashing method, the B was extracted using 0.36N H_2SO_4 by allowing 1 hr extracting time [10]. Wet digestion [4] with di acid (mixture of 9:4 ratio of nitric and perchloric acids) and tri acid (mixture of 9:4:1 of nitric, sulphuric and perchloric acids) were done in a closed system using digestion block. Throughout the analysis quartz and TPX glassware's were used to avoid the contamination from Borosilicate glassware's. The B extracted by different methods was determined by following the Azomethine-H method [10] using Varian Cary 50 UV Spectrophotometer. B concentration was determined at 420 nm and the response of the detector was recorded by the computer using the Cary 50 software.

Results and Discussion

Agricultural Wastes

Results showed that 93-98 and 74 – 97 per cent B was recovered from the organic wastes under di acid and tri acid digestions in a closed system respectively when compared to dry ashing method. Comparing the recovery of B between acid digestion methods (**Figure 1**), the B recovery is higher under di acid digestion (96 per cent) than in tri acid (85 per cent). The B content determined by the two extraction methods are 19.2 and 19.0 mg/kg in maize cob husk, 39.1 and 37.8 mg/kg in ground nut husk, 34.1 and 33.7 mg/kg in cotton bur, 15.2 and 14.5 mg/kg in FYM, 9.7 and 9.1 mg/kg in sugarcane trash, 21.9 and 20.4 mg/kg in castor cake, 37.8 and 35.2 mg/kg in ground nut cake under dry ashing and di acid closed digestion extraction methods, respectively. Higher recovery of boron was obtained in the cotton bur under di acid digestion (98.8 per cent) followed by the sugarcane trash (93.8 per cent) and this might be attributed to the higher concentration of calcium. The presence of higher amount of Ca enables the higher recovery of B from plant parts. Within the same extraction methods, the agro wastes of the same crop collected from different locations differed in their B content. This showed the influence of the genetic variation, fertilization practice, irrigation water and the quantum of rainfall besides season on the B content of the plant.

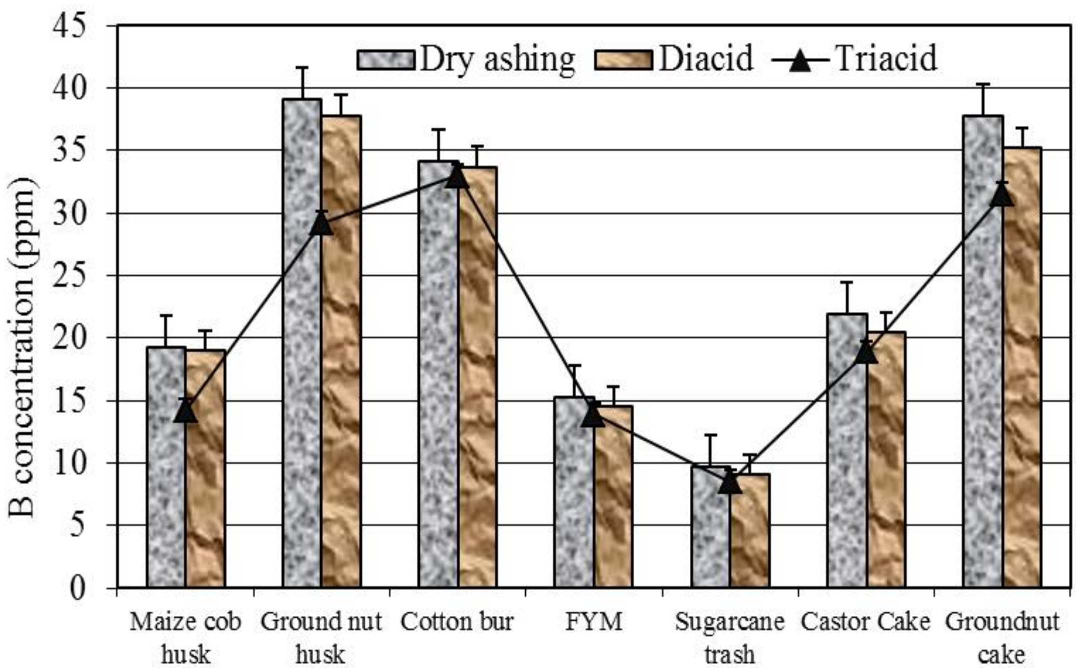

Figure 1 Efficiency of different methods of extraction on extracting B from various agricultural wastes

Efficiency of extraction methods and vermicompost

Vermicompost prepared from various organic wastes materials were collected and analyzed for B using different methods of extraction. In all the vermicompost lot, minimum of 25 per cent FYM was used along with the organic wastes. The results showed that the B content of vermicompost varied with the locations and lot. For the same production unit, B content varied from 7.5 to 42 mg/kg depending on the material used for vermicompost preparation. **Figure 2** showed that the B recovery was higher under di acid digestion when compared to tri acid for all the vermicompost lot except for the vermicompost prepared using town compost. In case of town compost the B recovery is 1 per cent higher than that in di acid method but is not significant and may be due to the interference of heavy metals in the town compost. Hence detailed study will be needed in these aspects to identify the suitable methods for the extraction of B from different organic wastes.

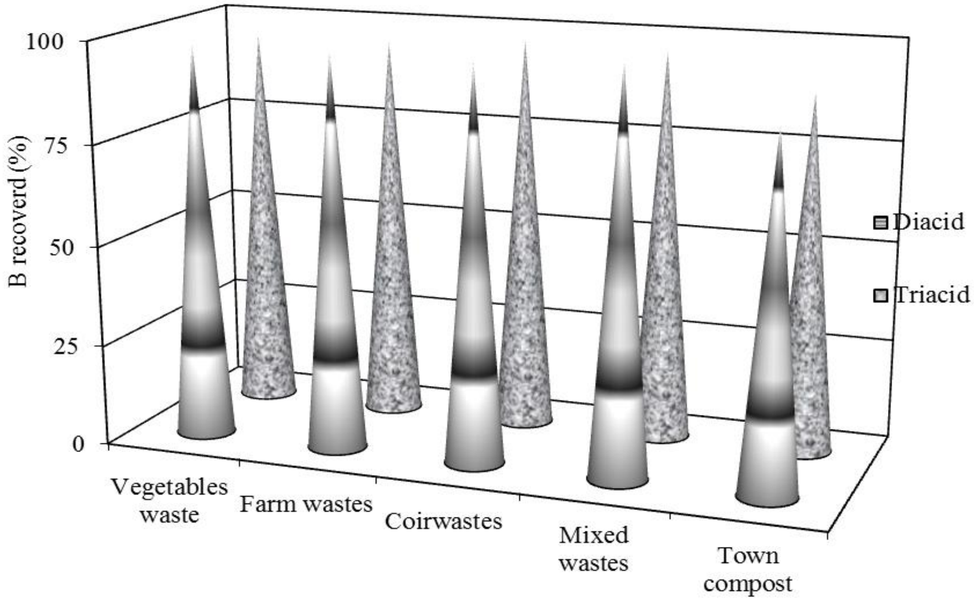

Figure 2 Variation of B concentration in vermicompost as affected by the type of wastes

Characterization of Fruits and Vegetables for B

Efficiency of dry ashing and di acid digestion methods were compared for the determination of B in the locally available fruits and vegetables (**Table 1**). In case of tomato, the B recovery was 100 per cent as that of the dry ashing technique. This again suggests that the di acid extracts can very well be used for the determination of B from calcium rich plant samples as it reduces the easy volatilization of B during digestion. In general, all cruciferous crops are rich in B content (Table 1) followed by tomato and fruits. Hence the inclusion of those wastes materials while preparing vermicompost for organic farming, may meet the B demand of the crop.

Table 1 B concentration in different fruits and vegetables as extracted by di acid digestion

Crop wastes	B content (mg/kg)	B recovery by diacid digestion in comparison with dry ashing
Mango	2	84.6
Papaya	14	89.7
Banana Skin	0.7	73.9
Cauliflower	23	90.7
Cabbage	26	92.2
Brinjal	16	88.9
Tomato	16	100.6
Onion	4	84.0
Onion Skin	0.6	90.3

The study suggests that while going for the multi nutrient analysis of the plant or organic wastes of plant origin, the di acid digestion under closed system is very much suitable for the B determination in addition to other nutrients. It reduces the time involved for the preparation of sample for B estimation using dry ashing method. Similar result was reported by Novozamsky et al. [11] that HNO_3, $HClO_4$ and hydrogen peroxide can be conveniently used for the decomposition of plant material to determine the B concentration.

Conclusion

The average B recovery was high under di acid digestion to the tune of 11 per cent than in tri acid and so while going for a multi nutrient analysis the di acid extraction of B is most suited than the triacid digestion. For the plant materials like cotton bur, tomato the B determined by the di acid digestion was as equal as that of dry ashing and suggest that di acid digestion can be used conveniently for the estimation of B in calcium rich plants. Among the different wastes characterized for B content, the ground nut husk has higher in B followed by cotton bur and other cruciferous vegetables. The study suggests that while doing organic farming, the inclusion of wastes materials which are rich in B content in compost making may met the B demand of the crop. While going for the multi nutrient analysis, adoption of di acid digestion under closed system is highly suitable for the B determination. This reduces the time involved in the preparation of sample for B using dry ashing method. Further detailed study is needed to find out the influence of agro environmental practices on B content in different organic wastes.

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