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Effects of Sowing Depths on Nutritional Metabolites of Three *Cucurbitaceae Species*

[1*]Ajayi, J. O. and [2]Ojewumi, A. W.

[1]Department of Pure and Applied Botany, Federal University of Agriculture, Abeokuta, Nigeria
[2]Department of Botany, Lagos State University, Ojo, Lagos, Nigeria.

Abstract

Variations in soil nutrients can influence the nutritional attributes of crops. Therefore, this study was conducted to evaluate the effects of varying sowing depths (2-8 cm) at 2 cm intervals on the nutritional contents of *Luffa cylindrica* (LC), *Citrullus lanatus* (CL) and *Citrullus colocynthis* (CC) fruits. Proximate, mineral and vitamin contents of seeds and pulps of fruits of the plants were determined. Protein (31.10±0.17 %), crude fibre (4.48±0.02 %), fat (47.13±0.27 %), ash (2.50±0.01 %) and carbohydrate (99.66±0.03 %) were higher ($p<0.05$) in seeds produced by CC sown at 6 cm compared with other sowing depths. Sodium (23.17±0.02 mg/100 g), potassium (370.47±0.34 mg/100 g), calcium (18.61±0.01 mg/100 g) and copper (0.25±0.01 mg/100 g) were higher in the pulp produced by seeds of LC sown at 6 cm. Similar significant increases were observed in phosphorus (13.28±0.11 mg/100 g), iron(8.12±0.01 mg/100 g), zinc(8.60±0.06 mg/100 g), and magnesium (2.28±0.01 mg/100 g) in seeds produced by LC seeds sown at 6 cm. Vitamin A (0.58±0.01 mg/100 g) and Vitamin K(0.19±0.15 mg/100 g) were also higher in seeds produced by CL seeds sown at 2 cm, Vitamin C (7.76±0.05 mg/100 g) and vitamin E(0.17±0.00 mg/100 g)in the pulp of CL seeds sown at 4 cm while Vitamin D (1.40±1.33 mg/100 g) was higher in the pulp produced by CC fruits whose seeds were sown at 6 cm. In conclusion, seeds of CC sown at 6 cm contained higher proximate and mineral compositions and vitamins in pulp than CL and LC. Therefore, cultivation of the plants at 4-6 cm is recommended to ensure a higher nutritional content of the plants.

Keywords: *Luffa cylindrica, Citrullus lanatus*, *Citrullus colocynthis*, proximate, vitamin

Introduction

The Cucurbits are dicotyledons that have certain features in common. The plants grow either prostrate along the ground or climb using tendrils. The leaves are large and simple but often deeply lobed, alternate or spirally arranged on long petioles. In each leaf axil, there is a flower bud, a vegetative bud and a tendril (Ajuru & Okoli, 2013).

Cucurbits are of high economic value, being major sources of utensils, items for decoration and food for man. They are used for diverse purposes in different parts of the country e.g. Asia, India, Ethiopia, Kenya, Zimbabwe, ranging from important items in the diet to occupying a special place in the life and culture of many ethnic groups (Lee & Yoo, 2006). Young *L. cylindrica* (Loofah) are used as vegetable, either prepared like squash, ,

* Corresponding Author: +234806899401
Email address: janetopeyemi93@gmail.com

or eaten raw like cucumbers (Lee & Yoo, 2006). In addition to being used as an edible vegetable, *L. cylindrica* also finds a wide application in packing medium, shoes, mats, soundproof linings, sponges, adsorbent for removal of heavy metals in wastewater and immobilization matrix for plants, algae, bacteria and yeasts (Demir *et al*., 2008).

Watermelon (*Citrullus lanatus*) is a nutritious and thirst-quenching fruit with 92% water by weight and also contains vitamins C and A. It is also rich in carotenoids, such as lycopene, phytofluene, phytoene, beta-carotene, lutein and neurosporene (De Lannoy, 2001). Melon (*Citrullus colocynthis*) is grown for its seed, which is used in preparing assorted foods, especially soup and stew. The seeds are also roasted and eaten as snacks (Ogbonna & Obi, 2007). Melon seed is rich in oil, minerals, vitamins, and protein and contains good quantities of most of the essential amino acids. The oil from melon seed is extracted and used for cooking and other industrial purposes, while the residue is used as soup thickener (Ogbonna & Obi, 2010).

In general, members of this family have always been considered a research subject due to their high economic importance with fruits of different shapes, sizes and flavours. However, these plants are poorly grown at different sowing depths and face survival challenges that really affect their nutritional contents. Sowing depth is important in maximizing the potential of growth and yield of any plant (Ahirwar, 2015). Srivastava *et al.* (2006) discovered that sowing depth can greatly influence Cucurbitaceae growth. It is, therefore, important to sow at accurate depth to achieve good germination, emergence, high plant population, good yield as well as nutritional contents of the plants. Although *L. cylindrica, C. lanatus* and *C. colocynthis* play key roles as vegetables, studies on their nutritional content are scanty. So, there is a need to examine the effects of sowing depth on the nutritional contents of *L. cylindrica, C. lanatus* and *C. colocynthis.*

Materials and Methods

Study Site

The experiment was carried out at the Botanical Garden of the Department of Pure and Applied Botany, Federal University of Agriculture, Abeokuta, Alabata, Ogun State, Nigeria (latitude 7° 22.84' N and longitude 3° 43.61' E).

Source of Seeds

Certified seeds of *L. cylindrica*, *C. lanatus* and *C. colocynthis* were collected from the Institute of Agricultural Research and Training (I.A.R&T), Ibadan, Oyo State, Nigeria.

Land Preparation and Experimental Design

This experiment was carried out using the method of Koffi *et al*. (2015). The experimental field was ploughed and harrowed manually. Three seeds were planted on each ridge in four replicates for each of the three plants and sown at 2 cm, 4 cm, 6 cm and 8 cm using a randomized complete block design.

Preparation of Pulp and Seeds for Laboratory Analysis

The seeds and pulp of the three plants sowed at 2, 4, 6 and 8cm were collected, air-dried and prepared for laboratory analysis according to the standard methods (AOAC, 2006).

Determination of Proximate Composition, mineral contents and vitamins of *L. cylindrica, C. lanatus* and *C. colocynthis* seeds and pulp.

Proximate compositions, mineral contents and vitamins of each plant were determined using standard methods (AOAC, 2006).

Statistical Analysis

Data obtained were analysed using Statistical Analysis System (SAS, 2013) Version 9.3. A two-way analysis of variance was conducted. Mean and Standard Error of the Means were separated using Duncan's Multiple Range Test (DMRT) at $p < 0.05$ significance level.

Results

Effect of varying sowing depths on nutritional compositions of *Luffa cylindrica*, *Citrullus colocynthis* and *Citrullus lanatus*fruits and seeds

Results showed that sowing depths produced significant effects on proximate contents in seeds and pulps of *L. cylindrica*, *C. colocynthis* and *C. lanatus* fruits. Crude protein (31.10±0.17%), crude fibre, (4.48±0.02%) fat (47.13±0.27%), ash (2.50±0.01%) and carbohydrate (99.66±0.03%) were significantly higher in seeds produced by CC sown at 6 cm compared with other sowing depths investigated. Also, the highest moisture contents (99.47±0.67%) were observed in the pulps produced by CC sown at 2 cm, as well as total sugar (6.18±0.04 %) in the pulp of CL whose seeds were sown at 6 cm (Table 1).

Effects of varying levels of sowing depths on mineral elements in *Luffa cylindrica*, *Citrullus colocynthis* and *Citrullus lanatus* fruits

Seeds were observed to be significantly influenced by variation in sowing depths. Sodium (23.17±0.02 mg/100 g), potassium (370.47±0.34 mg/100 g), calcium (18.61±0.01 mg/100 g) and copper (0.25±0.01 mg/100 g) were higher in the pulp produced by seeds of LC sown at 6 cm. Similar significant increases were observed in the quantity of phosphorus (13.28±0.11 mg/100 g), iron(8.12±0.01 mg/100 g), zinc (8.60±0.06 mg/100 g)and magnesium (2.28±0.01 mg/100 g) in seeds produced by LC seeds sown at 6 cm(Table 2). Vitamin A (0.58±0.01 mg/100 g) and Vitamin K(0.19±0.15 mg/100 g) were higher in seeds produced by CL seeds sown at 2 cm, Vitamin C (7.76±0.05 mg/100 g) and vitamin E (0.17±0.00 mg/100 g)in the pulp of seeds CL sown at 4 cm while Vitamin D (1.40±1.33 mg/100 g)was higher in the pulp of produced by CC fruits whose seeds were sown at 6cm (Table 3).

Discussion

Access of plant roots to soil nutrients plays a significant role in plants' maturation, yield production and other physiological processes. Significant variations recorded on the effects of sowing depths on the proximate, mineral and vitamin compositions of seeds and pulps of *L. cylindrica, C. colocynthis* and *C. lanatus* suggest that soil profiles at various horizons contain different nutrient levels which have different modulatory impacts on plants (Casanova & Brock, 2000; Mabapa *et al.,* 2017). Although the decay of plant and animal debris may begin on the topmost layer of soil, the majority of nutrients produced do move to subsoil due to leaching or percolation, thereby enriching subsoil more than topsoil (Osman & Osman, 2013; Kögel-Knabner & Amelung, 2021). This might be evident in the 6cm depth being considered nutritionally richer than other planting depths (Macadam & Bedford, 1998).

In addition, seeds are expected to be nutritionally richer compared with other parts of the plants in order to enhance germination and perennation and to ensure the continuity of the natural cycles of plants (Crawford, 2008).

Also, high carbohydrates recorded in the pup may indicate that, unlike the pulp, the seeds of the plants contain higher amounts of energy in the form of adenosine triphosphate needed by the seeds to power the metabolic process of the parts. The energy may also be a potential source of nutrients for plumule and radicle before the emergence of mature leaves during germination (Ashraf & Foolad, 2005).

The soil depth modulates the level of mineral elements in the seeds and pulps of the plants. It acts as an inorganic cofactor, which is known to influence metabolic processes during germination and other growth phases of plants (Martins et al., 2021). Hence, a small or insufficient quantity of these inorganic cofactors could result in metabolic impairment of plants at either growth or developmental stages (Soetan *et al.,* 2010). In another related development, Jacob *et al*. (2015) reported higher iron, magnesium, manganese and zinc contents in *C. lanatus* than what was obtained in this study. This could be due to the quality of seeds, soil type and other edaphic factors, as it has been reported that yields of crops could be a function of geographical location or health status of the soil. Potassium was high in the pulp of *L. cylindrica* planted at 6 cm; it is also high in the seed of *C. colocynthis* sowed at 6 cm as well as the pulp of *C. lanatus* at 6 cm depth, while calcium, copper and manganese were significantly higher in the pulp of *L. cylindrical* and *C. colocynthis* sowed at the same sowing depth.

The presence of these minerals in adequate amounts enhances the normal physiological functions such as nutrient utilization and mineralization in the plants (Adeyeye, 2000), as well as for the prevention and control of the disease. Therefore, this observation may contribute to sowing depths to the medicinal potential of the pulp and seeds of the plants (Aliyu *et al*., 2008). Although the nutritional responses of cucurbits

Table 1: Effect of different sowing depths on proximate contents of *Luffa cylindrica* (LC), *Citrullus colocynthis* (CC) and *Citrullus lanatus* (CL) fruits and seeds

Sowing depths (cm)	Proximate content (%)						
	Crude Protein	**Crude Fibre**	**Fat**	**Ash**	**Carbohydrate**	**Moisture**	**Total Sugar**
2 (pulp) LC	0.32±0.01^{d}	2.61±0.02^{b}	0.09±0.01^{d}	1.17±0.01^{bc}	99.27± 0.02^{ab}	91.85±0.1^{ab}	1.25±0.01^{c}
2 (pulp) CC	0.46±0.21^{d}	0.04±0.0^{c}	0.07±0.03^{d}	0.04±0.01^{c}	99.42±0.05^{ab}	85.42±5.15^{b}	2.72±0.01^{c}
2 (Pulp) CL	0.33±0.01^{fd}	0.02±0.01^{c}	0.02±0.01^{d}	0.00±0.33^{c}	99.50±0.01^{ab}	99.47±0.67^{a}	3.31±0.05^{c}
2 (seed) LC	0.47±0.01^{d}	0.03± 0.00^{c}	0.12 ±0.00^{d}	0.02 ±0.00^{c}	99.36±0.01^{ab}	90.78± 0.37^{ab}	1.42± 0.01^{c}
2 (seed) CC	21.80±0.15^{c}	3.32±0.04^{ab}	38.35±0.22^{c}	1.22±0.01^{bc}	35.32±0.34^{b}	81.63±0.67^{b}	3.71±0.02^{c}
2 (Seed) CL	0.51±0.01^{d}	0.03±0.01^{c}	0.14±0.01^{d}	0.06±0.01^{c}	99.26±0.01^{ab}	96.14±0.01^{ab}	4.15±0.03^{bc}
4 (pulp) LC	0.37 ±0.00^{d}	2.75 ±0.01^{b}	0.12± 0.00^{d}	1.29± 0.01^{bc}	95.80±0.04^{ab}	80.70±0.21^{b}	1.40±0.00^{c}
4 (pulp) CC	0.02±0.14^{d}	0.09±0.00^{c}	0.05±0.00^{d}	0.04±0.00^{c}	99.50±0.04^{ab}	83.03±1.70^{b}	3.15±0.01^{c}
4 Pulp) CL	0.40±0.02^{d}	0.13±0.01^{c}	0.04±0.01^{d}	0.06±0.01^{c}	99.37±0.01^{ab}	71.70±18.34c	2.13±1.67^{c}
4 (seed) LC	0.52 ±0.01^{d}	0.03± 0.00^{c}	0.15± 0.01^{d}	0.02± 0.00^{c}	95.47± 0.02^{ab}	82.48± 0.19^{ab}	1.49±0.01^{c}
4 (seed) CC	26.27±0.15^{b}	4.13±0.02^{ab}	44.55±0.21^{b}	2.42±0.06^{bc}	22.63±0.22^{c}	75.0±0.35^{c}	4.31±0.03^{bc}
4 (Seed) CL	0.63±0.01^{d}	0.06±0.02^{c}	0.16±0.02^{d}	0.10±0.01^{c}	99.05±0.01^{ab}	93.37±0.38^{ab}	5.57±0.08^{ab}
6 (Pulp) LC	0.61±0.01^{d}	2.68± 0.25^{ab}	0.80±0.33^{d}	1.41± 0.01^{bc}	95.35± 0.26^{ab}	78.85±2.60^{c}	1.51±0.01^{c}
6 (Pulp) CC	0.50±0.01^{d}	0.09±0.01^{c}	0.06±0.00^{d}	0.04±0.00^{c}	14.79±0.37^{d}	90.66±0.26^{ab}	4.22±0.06^{bc}
6 (Pulp) CL	0.43±0.01^{d}	0.13±0.01^{c}	0.04±0.01^{d}	0.05±0.02^{c}	99.34±0.02^{ab}	96.20±0.11^{ab}	6.18±0.04^{a}
6 (seed) LC	0.41±0.00^{d}	0.05± 0.00^{c}	0.24± 0.01^{d}	0.02± 0.00^{c}	99.09± 0.02^{ab}	93.05± 0.35^{ab}	2.81±0.01^{c}
6 (seed) CC	31.10±0.17^{a}	4.48±0.02^{a}	47.13±0.27^{a}	2.50±0.01^{a}	99.66±0.03^{a}	89.81±0.16^{ab}	5.11±0.04^{ab}
6 (Seed) CL	0.66±0.01^{d}	0.06±0.01^{c}	0.02±0.01^{d}	0.07±0.01^{c}	99.04±0.03^{ab}	88.50±0.42^{ab}	5.90±0.07^{ab}
8 (pulp) LC	0.35±0.01^{d}	2.71±0.01^{b}	0.10± 0.00^{d}	1.24± 0.01^{bc}	95.60±0.01^{ab}	82.47±1.13^{ab}	1.31±0.01^{c}
8 (pulp) CC	0.48±0.00^{d}	0.07±0.00^{c}	0.04±0.00^{d}	0.15±0.12^{c}	99.25±0.13^{ab}	92.41±0.70^{ab}	3.80±0.00^{c}
8 (pulp) CL	0.39±0.01^{d}	0.10±0.01^{c}	0.02±0.01^{d}	0.04±0.01^{c}	99.44±0.03^{ab}	95.26±0.97^{ab}	5.68±0.12^{ab}
8 (seed) LC	0.49±0.01^{d}	0.04±0.00^{c}	0.14±0 .00^{d}	0.02±0.00^{c}	98.65±0.33^{ab}	92.87±0.46^{ab}	1.19±0.01^{c}
8 (seed) CC	28.07±0.32^{ab}	3.55±0.07^{ab}	45.13±0.26^{b}	2.08±0.03^{ab}	21.18±0.56^{c}	90.93±0.09^{ab}	4.62±0.01^{bc}
8 (Seed) CL	0.63±0.01	0.05±0.01^{c}	0.14±0.02^{d}	0.06±0.01^{c}	99.11±0.02^{ab}	90.55±0.61^{ab}	5.58±0.03^{ab}

Means ± Standard error of the mean with different superscripts in columns are significantly different using Duncan's Multiple Range Test at P < 05

LC- *Luffa cylindrica*, CC – *Citrullus colocynthis* and CL – *Citrullus lanatus*.

Table 2: Effect of different sowing depths on mineral contents of *Luffa cylindrica* (LC), *Citrullus colocynthis* (CC) and *Citrullus lanatus* (CL) fruits and seeds

Sowing depths (cm)	Proximate content (mg/100g)							
	Sodium	**Potassium**	**Calcium**	**Phosphorus**	**Iron**	**Zinc**	**Magnesium**	**Copper**
2 (pulp) LC	18.30±0.06^{b}	357.50±0.50^{bc}	14.75±0.06^{b}	7.33±0.09^{c}	0.30±0.00^{cd}	0.04±0.00 ^{d}	0.38±0.00^{b}	0.17±0.01^{b}
2 (pulp) CC	0.18±0.00^{f}	117.57±0.68^{j}	4.60±0.02^{de}	8.79±0.06^{c}	0.39±0.01^{cd}	0.41±0.00^{c}	0.14±0.00^{b}	0.17±0.01^{b}
2 (Pulp) CL	0.57±0.01^{d}	125.17±0.78^{j}	5.66±0.04^{c}	7.71±0.11^{c}	0.23±0.00^{cd}	0.13±0.01^{d}	0.17±0.00^{b}	0.11±0.01^{b}
2 (seed) LC	12.53 ±0.04^{c}	220.60±0.25^{d}	4.60 ±0.02^{de}	5.53 ±0.04^{d}	0.26±0.01^{cd}	0.02± 0.00^{d}	0.12± 0.00^{b}	0.06± 0.00^{c}
2 (Seed) CC	0.60±0.01^{d}	155.66±0.61^{gh}	4.52±0.04^{de}	10.70±0.11^{b}	6.39±0.01^{ab}	5.40±0.01^{b}	1.13±0.01^{b}	0.14±0.01^{b}
2 (Seed) CL	0.26±0.01^{ef}	134.00±0.75^{ij}	3.72±0.01^{e}	9.43±0.02^{b}	0.46±0.00^{cd}	0.16±0.00^{d}	0.21±0.01^{ab}	0.13±0.01^{b}
4 (pulp) LC	21.18±0.27^{ab}	362.95±0.27^{ab}	16.85± .04^{ab}	8.70±0.01^{c}	0.39± 0.01^{cd}	0.07± 0.00^{d}	0.29±0.13^{b}	0.21±0.00^{ab}
4 (pulp) CC	0.20±0.01^{f}	118.00±1.03^{j}	5.70±0.01^{c}	9.81±0.03^{b}	0.50±0.01^{c}	0.47±0.01^{c}	0.20±0.01^{b}	0.23±0.00^{ab}
4 (Pulp) CL	0.63±0.01^{d}	147.10±0.72^{h}	6.92±0.01^{c}	8.89±0.06^{c}	1.26±0.00^{c}	0.35±0.01^{d}	0.33±0.01^{b}	0.17±0.01^{b}
4 (seed) LC	16.37±0.01^{b}	237.07±0.32^{d}	4.84± 0.01^{de}	6.71± 0.01^{d}	0.28±0.02^{cd}	0.04± 0.00^{d}	0.16±0.00^{b}	0.07±0.01^{c}
4 (Seed) CC	0.23±0.01^{f}	166.86±0.04^{f}	5.75±0.05^{c}	12.65±0.03^{ab}	7.80±0.03^{ab}	7.73±0.06^{ab}	1.25±0.01^{ab}	0.22±0.00^{ab}
4 (Seed) CL	0.29±0.01^{e}	141.72±0.31^{h}	5.51±0.05^{c}	11.37±0.16^{c}	0.51±0.01^{c}	0.25±0.01^{d}	0.29±0.01^{b}	0.17±0.00^{b}
6 (Pulp) LC	23.17±0.02^{a}	370.47±0.34^{a}	18.61±0.01^{a}	9.92± 0.02^{b}	0.43± 0.01^{cd}	0.08± 0.00^{d}	0.43±0.01^{b}	0.25±0.01^{a}
6 (pulp) CC	0.65±0.01^{d}	120.93±0.24^{j}	6.41±0.02^{c}	10.25±0.03^{b}	0.54±0.01^{c}	0.52±0.00c	0.20±0.00^{b}	0.24±0.00^{ab}
6 (Pulp) CL	22.742.13^{a}	160.64±0.53^{f}	5.19±0.13^{c}	11.33±0.24^{ab}	6.81±0.03^{c}	5.80±0.06^{b}	1.14±0.01^{ab}	0.16±0.00^{b}
6 (seed) LC	21.46±0.38^{ab}	241.45±0.38^{cd}	5.71± 0.02^{c}	7.46± 0.03^{c}	0.35± 0.01^{cd}	0.08± 0.00^{d}	0.21±0.00^{b}	0.10±0.00^{b}
6 (Seed) CC	0.65±0.02^{d}	171.20±1.39^{ef}	6.25±0.05^{c}	13.28±0.11^{a}	8.12±0.01^{a}	8.60±0.06^{a}	2.28±0.01^{a}	0.23±0.01^{ab}
6 (Seed) CL	0.32±0.01^{e}	144.77±0.58^{h}	5.76±0.06^{c}	11.03±0.36^{ab}	0.54±0.04^{c}	0.29±0.01^{d}	0.30±0.02^{b}	0.18±0.01^{b}
8 (pulp) LC	18.12±0.01^{b}	354.65±3.75^{b}	15.48± 0.31^{ab}	7.80±0.01^{c}	0.36±0.01^{cd}	0.06±0.00^{d}	0.41±0.01^{b}	0.16±0.00^{b}
8 (pulp) CC	0.24±0.00^{ef}	119.07±0.27^{j}	5.55±0.15^{c}	9.78±0.02^{b}	0.57±0.01^{c}	0.50±0.00^{c}	0.17±0.01^{b}	0.22±0.00^{b}
8 (pulp) CL	0.62±0.01^{d}	156.20±0.76^{gh}	4.57±0.07^{de}	10.50±0.01^{b}	5.78±0.03^{b}	5.40±0.10^{b}	1.09±0.01^{ab}	0.13±0.00^{ab}
8 (seed) LC	18.73±0.01^{b}	250.97±0.33^{c}	4.54±0.03^{de}	5.91±0.02^{d}	0.28±0.01^{cd}	0.02±0.01^{d}	0.14±0.00^{b}	0.04±0.02^{c}
8 (Seed) CC	0.60±0.01^{d}	168.27±0.82^{f}	5.39±0.01^{de}	12.68±0.01^{ab}	7.48±0.03^{ab}	7.27±0.01^{ab}	1.27±0.01^{ab}	0.22±0.00^{ab}
8 (Seed) CL	0.30±0.00^{e}	140.80±0.15^{h}	4.72±0.15^{de}	9.60±0.02^{b}	0.54±0.00^{c}	0.26±0.00^{d}	0.30±0.00^{b}	0.16±0.00^{b}

Means ± standard error with different superscripts in columns are significantly different using Duncan Multiple Range Test at P < 0

Table 3: Effect of different sowing depth on vitamins in *Luffa cylindrica* (LC), *Citrullus colocynthis* (CC) and *Citrullus lanatus* (CL) fruits and seeds

Sowing depth (cm)	Vitamins (%)				
	Vitamin A	Vitamin C	Vitamin D	Vitamin E	Vitamin K
2 (pulp) LC	$0.34±0.00^{d}$	$4.91±0.01^{bc}$	$0.51±0.01^{b}$	$0.03±0.00^{d}$	$0.02±0.00^{c}$
2 (pulp) CC	$0.37±0.01^{d}$	$4.81±0.03^{bc}$	$0.03±0.00^{e}$	$0.04±0.00^{d}$	$0.02±0.001^{c}$
2 (Pulp) CL	$0.35±0.01^{d}$	$5.68±0.04^{b}$	$0.05±0.00^{d}$	$0.11±0.00^{b}$	$0.03±0.00^{c}$
2 (seed) LC	$0.21±0.00^{f}$	$1.73± 0.73^{d}$	$0.29 ±0.01^{c}$	$0.04 ±0.00^{d}$	$0.03±0.00^{c}$
2 (Seed) CC	$0.25±0.01^{e}$	$3.71±0.02^{c}$	$0.05±0.01^{d}$	$0.02±0.00^{d}$	$0.02±-0.00^{c}$
2 (Seed)CL	$0.58±0.01^{a}$	$0.03±0.00^{f}$	$0.04±0.00^{d}$	$0.11±0.01^{b}$	$0.19±0.15^{a}$
4 (pulp) LC	$0.38±0.00^{d}$	$4.94 ±0.02^{bc}$	$0.60± 0.00^{b}$	$0.04± 0.01^{d}$	$0.05± 0.00^{b}$
4 (pulp) CC	$0.30±0.01^{de}$	$5.72±0.01^{b}$	$0.05±0.01^{d}$	$0.08±0.00^{c}$	$0.04±0.00^{c}$
4 (Pulp)CL	$0.54±0.01^{ab}$	$7.76±0.05^{a}$	$0.08±0.01^{d}$	$0.17±0.00^{a}$	$0.05±0.01^{b}$
4 (seed) LC	$0.22 ±0.01^{f}$	$3.11± 0.02^{c}$	$0.34± 0.01^{c}$	$0.06± 0.00^{c}$	$0.04± 0.01^{c}$
4 (Seed) CC	$0.38±0.01^{d}$	$4.86±0.05^{bc}$	$0.07±0.00^{d}$	$0.06±0.01^{c}$	$0.06±0.00^{b}$
4 (Seed)CL	$0.43±0.18^{c}$	$0.06±0.00^{f}$	$0.07±0.01^{d}$	$0.14±0.00^{ab}$	$0.07±0.01^{b}$
6 (Pulp)LC	$0.41±0.01^{c}$	$5.35±0.02^{b}$	$0.63± 0.01^{b}$	$0.06± 0.01^{c}$	$0.06± 0.01^{b}$
6 (pulp) CC	$0.31±0.01^{de}$	$6.61±0.03^{b}$	$1.40±1.33^{a}$	$0.10±0.00^{b}$	$0.04±0.00^{c}$
6 (Pulp)CL	$0.50±0.01^{bc}$	$7.40±0.02^{ab}$	$0.07±0.00^{d}$	$0.13±0.01^{b}$	$0.05±0.00^{b}$
6 (seed) LC	$0.26± 0.01^{e}$	$4.84±0.04^{bc}$	$0.35± 0.01^{c}$	$0.08± 0.00^{c}$	$0.07± 0.00^{b}$
6 (Seed) CC	$0.39±0.01^{d}$	$5.35±0.12^{b}$	$0.07±0.01^{d}$	$0.05±0.00^{c}$	$0.08±0.01^{b}$
6 (Seed)CL	$0.55±0.01^{ab}$	$0.05±0.00^{f}$	$0.06±0.00^{d}$	$0.15±0.00^{ab}$	$0.07±0.00^{b}$
8 (pulp) LC	$0.35±0.01^{d}$	$3.37± 0.01^{c}$	$0.55± 0.01^{b}$	$0.04±0.00^{d}$	$0.03±0.00^{c}$
8 (pulp) CC	$0.27±0.00^{f}$	$5.81±0.00^{b}$	$0.06±0.00^{d}$	$0.08±0.00^{c}$	$0.02-±0.00^{c}$
8 (Pulp)CL	$0.50±0.01^{bc}$	$4.92±2.36^{bc}$	$0.06±0.00^{d}$	$0.12±0.00^{b}$	$0.05±0.00^{b}$
8 (seed) LC	$0.20±0.00^{g}$	$3.10±0.01^{c}$	$0.31±0.00^{c}$	$0.05±0.00^{c}$	$0.04±0.01^{c}$
8 (Seed) CC	$0.18±0.08^{g}$	$4.73±0.02^{bc}$	$0.05±0.00^{d}$	$0.03±0.00^{d}$	$0.05±0.01^{b}$
8 (Seed)CL	$0.42±0.01^{c}$	$0.04±0.00^{f}$	$0.06±0.01^{d}$	$0.08±0.53^{c}$	$0.07±0.00^{b}$

Means ± standard error with different superscripts in columns are significantly different using Duncan Multiple Range Test at $P < 0.05$
LC- *Luffa cylindrica*, CC – *Citrullus colocynthis* and CL – *Citrullus lanatus*.

ed variations across the depths, yet 6 cm sowing depths increased metabolites investigated. Therefore, the sowing depth of 6 cm is considered the optimum planting depth to ensure high nutritional contents of *L. cylindrica, C. colocynthis* and *C. lanatus.*

Conclusion

L. cylindrica, C. colocynthis, and *C. lanatus* pulp and seeds planted at optimum sowing depth of 6 cm contained higher nutritional values among different sowing depths. Hence, cultivation of the plants at 6 cm is recommended for high nutritional value.

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