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Yield and nutrient content of hydroponics cowpea sprouts at various stages of growth

P K NAIK[1], B D DHAWASKAR[2], D D FATAERPEKAR[3], B K SWAIN[4], E B CHAKURKAR[5] and N P SINGH[6]

ICAR-Central Coastal Agricultural Research Institute, Old Goa, Goa 403 402 India

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Owing to unavailability of green fodder, supplementation of hydroponics sprouts in the ration of dairy animals is coming up as a viable alternate technology for the livestock farmers (Naik and Singh 2014, Naik *et al.* 2015). During sprouting, due to neutralization of enzyme inhibitors, activities of the inactive enzymes of the grains are increased, and also help in the elimination of antinutritional factors of the seeds. Sprouts are good source of enzymes, antioxidants and chlorophyll, which improves the performance of the livestock (Chavan and Kadam 1989, Sneath and Mclntosh 2003). Cowpea (*Vigna unguiculata*) is one of the important crops, grown in different parts of India and used as pulse, vegetable and fodder. There are numerous genotypes of cowpea and NB-4 is one of them. However, only a few reports are available on the nutrient content of hydroponically sprouted grains in India (Reddy *et al*. 1988, Naik *et al*. 2015). Therefore, an experiment was conducted to find out the yield and nutrient content of hydroponics cowpea (*Vigna unguiculata*) (NB-4) sprouts at various stages of growth.

Hydroponics cowpea (NB-4) sprouts were produced daily for 15 days in a hydroponics chamber (greenhouse) measuring about 25 ft × 10 ft × 10 ft, equipped with automatic sprayer irrigation of tap water. Clean seeds of cowpea with seed rate of 2.54 kg/m^2 with replicates of 15 were soaked in tap water individually for 4 h. The seeds were strained and spread in the greenhouse trays. Inside the greenhouse, each replicate was allowed to grow for 9 days, after which it was harvested. Samples of the hydroponics cowpea sprouts were analysed for different nutrients content, viz. crude protein (CP), ether extract (EE), crude fiber (CF), nitrogen free extract (NFE), total ash (TA) and acid insoluble ash (AIA) as per AOAC (2000). The data were analysed statistically for the test of significance (Snedecor and Cochran 1994).

Present address: [1]Principal Scientist (pknaikicar@gmail.com), Animal Nutrition, [4]Principal Scientist (nbkswain@gmail.com), Regional Centre (RC), ICAR-Central Avian Research Institute (CARI), Bhubaneshwar. [2,3]SRF (bhaveshdhawaskar@yahoo.in, dfatarpekar@gmail.com), [5]Principal Scientist (eknchakurkar @yahoo.com), [6]Director (narendraprataps@yahoo.co.in).

During the advancement of growth period, the hydroponically sprouted cowpea (NB-4) looked like a mat consisting of germinated seeds, white roots and green shoots and reached a height of about of 25–30 cm in about 7 days. Similar to this study, the hydroponically sprouted maize grains were 20–30 cm in height at the end of the sprouting period of 7 days (Naik *et al.* 2016a, b). By the end of the germination period of 8 days, the wheat, barley and oat seedlings were approximately 11.0, 14.0 and 11.5 cm in height, respectively (Snow *et al.* 2008). Depending upon the type of grain, the forage mat reaches 15–30 cm height (Mukhopad 1994).

The fresh yield (kg/kg seed) of the hydroponically sprouted cowpea (NB-4) increased ($P<0.05$) with the advancement of growing period and remained similar, and highest from 6th day (6.34) to 9th day (6.63) growing period (Table 1). Simultaneously, with the growth of the hydroponics cowpea sprouts, the DM content (%) decreased and remained similar, and lowest from 8th day (6.91) to 9th day (6.49) growing period. The increase in fresh weight and decrease in the DM content during sprouting of seeds are mainly attributed to the imbibition of water and enzymatic activities, respectively, which depletes the food reserves of the seed endosperm without any adequate replenishment from photosynthesis by the young plant and thus provides little chance for DM accumulation during short growing cycle (Sneath and McIntosh 2003). Moreover, the decrease in DM of the sprouts may be due to leaching and oxidation of the substances from the seed (Morgan *et al.* 1992). During photosynthetic activities, respiration in the young plant brings about a net loss in DM, when sprouting is completed. In a 7 d sprout, photosynthesis commences around day 5, when the chloroplasts are activated and this does not provide enough time for any significant DM accumulation (Dung *et al.* 2010). Yields of hydroponics fodder up to 8 folds and DM up to 15% are common in commercial advertisements, while trial yields ranged from 5–8 folds (Sneath and Mclntosh 2003). There was report of 5.5 times increase in the fresh weight of cowpea with 15% DM after sprouting (AI-Karaki and AI-Hashimi 2012). Fresh yield of 2.8–8 folds in 6–8 days with DM content of 8.0–19.7%, and fresh yield of 3.5–6.0 folds

Table 1. Yield and nutrient content (on % DM basis) of hydroponics cowpea (NB-4) sprouts

Nutrient	Days of growth in hydroponics greenhouse								
	1	2	3	4	5	6	7	8	9
Fresh yield (kg)/kg seed*	4.00± 0.02^{a}	4.46± 0.02^{ab}	5.02± 0.07^{bc}	5.16± 0.06^{c}	5.55± 0.15^{c}	6.34± 0.27^{d}	6.41± 0.25^{d}	6.45± 0.21^{d}	6.63± 0.06^{d}
Dry matter*	41.42± 0.14^{a}	34.44± 0.23^{b}	25.55± 0.04^{c}	18.46± 0.06^{d}	12.84± 0.40^{e}	10.51± 0.04^{f}	8.59± 0.23^{g}	6.91± 0.10^{h}	6.49± 0.21^{h}
Crude protein*	22.30± 0.22^{a}	23.47± 0.10^{a}	25.19± 0.39^{b}	26.78± 0.37^{c}	27.84± 0.39^{c}	27.97± 0.27^{c}	30.10± 0.24^{d}	30.50± 0.70^{d}	31.23± 0.29^{d}
Ether extract*	1.24± 0.03^{a}	1.31± 0.04^{ab}	1.37± 0.04a^{b}	1.59± 0.03^{b}	2.31± 0.09^{c}	2.39± 0.16^{c}	2.39± 0.07^{c}	2.47± 0.07^{c}	3.22± 0.03^{d}
Crude fiber*	6.55± 0.13^{a}	6.59± 0.16^{a}	7.56± 0.13^{b}	8.17± 0.10^{b}	10.83± 0.30^{c}	13.88± 0.29^{d}	15.93± 0.42^{e}	17.64± 0.19^{f}	21.59± 0.19^{g}
Nitrogen free extract*	65.92± 0.35^{h}	64.62± 0.29^{h}	61.85± 0.53^{g}	59.37± 0.37^{f}	54.92± 0.32^{e}	51.47± 0.14^{d}	47.01± 0.25^{c}	44.56± 0.52^{b}	38.59± 0.64^{a}
Total ash*	3.99± 0.01^{a}	4.01± 0.02^{a}	4.02± 0.02^{a}	4.10± 0.02^{ab}	4.11± 0.06^{ab}	4.30± 0.14^{ab}	4.56± 0.02^{bc}	4.83± 0.03^{c}	5.38± 0.28^{d}
Acid insoluble ash*	0.06± 0.01^{a}	0.07± 0.0^{a}	0.07± 0.01^{a}	0.07± 0.01^{a}	0.07± 0.01^{a}	0.08± 0.01^{ab}	0.08± 0.01^{ab}	0.09± 0.01^{ab}	0.11± 0.01^{b}

* Means bearing different superscripts in a row differ significantly (P<0.05).

in 7–8 days with DM content of 10.3–18.5% has been reported for hydroponics barley and maize fodder, respectively (Naik *et al.* 2015).

The CP (%) of the hydroponics cowpea sprouts (NB-4) was lowest (P<0.05) on the 1st day (22.30), then increased and remained similar during 7th (30.10) to 9th (31.23) day sprouting period. The increase in CP content may be attributed to the loss in DM, particularly carbohydrates, through respiration during germination and thus longer sprouting time is responsible for greater losses in DM and increase in protein content (Dung *et al.* 2010). Besides, the absorption of nitrates facilitates the metabolism of nitrogenous compounds from carbohydrate reserves, thus increasing the CP levels (Sneath and Mclntosh 2003). The changes in the protein contents occur rapidly from day 4 corresponding with the extension of the radical (root), which allows mineral uptake (Morgan *et al.* 1992). The EE content increased and remained similar (P>0.05) during day 5 (2.31%) to day 8 (2.47%) of sprouting, however, it was highest on day 9 (3.22) of growth. It may be due to the increase in the structural lipids and production of chlorophyll associated with the plant growth. During the growth period of the hydroponics cowpea sprouts, the CF(%) and NFE(%) had an increasing and decreasing trend; and was highest and lowest, respectively, on day 9 (21.59 and 38.59). This may be attributed to the increase in the number and size of cell walls for the synthesis of structural carbohydrates (Sneath and Mclntosh 2003, Fazaeli *et al.* 2012). There was an increasing trend in the TA and AIA content of the hydroponically sprouted cowpea with the advancement of the growth period, which was lowest on day 1 (3.99) and highest (5.38) on day 9. During the sprouting process, the total ash content was increased (Dung *et al.* 2010, Fazaeli *et al.* 2012) with the suggested mechanism that the higher OM, particularly starch is consumed to support the metabolism and energy requirement of the growing plant (Chavan and Kadam 1989), therefore resulted in a lower OM and higher ash in sprouted grains. Morgan *et al.* (1992) found that the ash content of sprouts increased from day 4 corresponding with the extension of the root, which allowed mineral uptake. Similar to this study, Naik *et al.* (2012) observed increase in CP, EE, CF and TA content and decrease in NFE content during the growth of hydroponics maize fodder. In India, there are reports of increase in digestibility of nutrients, growth rate and milk yield by feeding of hydroponics green fodder or hydroponically sprouted grains (Naik *et al*. 2014, Verma *et al*. 2015, Naik *et al.* 2016a,b).

It can be concluded that based on the yield and different nutrient contents, cowpea (NB-4) can be sprouted hydroponically for 6–9 days to use as feed supplement for dairy animals.

SUMMARY

Hydroponics cowpea (*Vigna unguiculata*) (NB-4) sprouts were produced daily for 15 days in a hydroponics chamber (greenhouse) equipped with automatic sprayer irrigation of tap water. Cowpea (NB-4) with seed rate of 2.54 kg/m^2 with replicates of 15 was soaked in tap water individually for 4 h.The seeds were strained and spread in the greenhouse trays. Inside the greenhouse, each replicate was allowed to grow for 9 d, after which it was harvested. The fresh yield (kg/kg seed) of the hydroponically sprouted cowpea (NB-4) increased with the advancement of growing

period and remained similar and highest from day 6 (6.34) to 9 (6.63) growing period. Simultaneously, with the growth of the hydroponics cowpea sprouts, the DM content (%) decreased and remained similar and lowest from day 8 (6.91) to day 9 (6.49) growing period. The CP(%) of the hydroponics cowpea fodder was lowest on the day 1 (22.30), then increased and remained similar during seventh (30.10) to ninth (31.23) day sprouting period. The EE content increased and remained similar during day 5 (2.31%) to 8 (2.47%) of sprouting, however, it was highest on day 9 (3.22) of growth. During the growth period of the hydroponics cowpea sprouts, the CF(%) and NFE(%) had an increasing and decreasing trend and was highest and lowest, respectively, on day 9 (21.59 and 38.59). There was an increasing trend in the TA and AIA content of the hydroponics cowpea sprouts with the advancement of the growth period, which was lowest on day 1 (3.99) and highest (5.38) on day 9. It can be concluded that based on the yield and different nutrient contents, cowpea (NB-4) can be sprouted hydroponically for 6–9 days to use as feed supplement for dairy animals.

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