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Nutrient changes during sprouting of hydroponics Alsando (*Vigna unguiculata*)

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The potential health benefits of sprouted grains are well known since long years (Chavan and Kadam 1989, Sneath and Mclntosh 2003). Sprouting of grains breaks down the reserve chemical constituents that are used to make new compounds or transported to the other parts of the growing seedling and breakdown the nutritionally undesirable constituents, leading to increase in the quality of the amino acids and concentrations of the vitamins. Sprouts are good source of anti-oxidants, chlorophyll, enzymes and alkaline in nature, which improve the animals' productivity by developing a stronger immune system. Besides, sprouting helps in the elimination of the anti-nutritional factors and contains a grass juice factor that improves the performance of the livestock (Finney 1982, Chavan and Kadam 1989, Sneath and Mclntosh 2003). Therefore, due to unavailability of green fodder, supplementation of sprouted grains 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, 2016a).

Cowpea (*Vigna unguiculata*) is one of the important pulse, vegetable and fodder crops grown in different parts of Goa and India. There are numerous varieties of cowpea available, but Goan cowpea (locally called Alsando) is unique and is being cultivated by the farmers. However, only a few reports are available on the nutrient content of hydroponically sprouted maize grains (Naik *et al*. 2012, 2016b, 2017a) and cowpea grains (Naik *et al*. 2016c, 2016d) in India. Therefore, an experiment was conducted to find out the nutrient changes during sprouting of hydroponics Alsando (*Vigna unguiculata*).

Hydroponically sprouted Alsando was produced daily in a hydroponics chamber (greenhouse) measuring about 25 ft × 10 ft × 10 ft equipped with automatic sprayer irrigation of simply tap water (without nutrient solution/ fertilizer). Clean seeds of Alsando 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 put on the greenhouse trays. Inside the greenhouse, they were allowed to grow for 9 days. The experiment was conducted for a period of 15 days. Samples sprouted Alsando were analyzed for the nutrients content, viz. crude protein (CP), ether extract (EE), crude fibre (CF), nitrogen free extract (NFE), total ash (TA) and acid insoluble ash (AIA) as per AOAC (2000). The data were analyzed statistically for the test of significance (Snedecor and Cochran 1994).

During the advancement of growth period, the hydroponics Alsando looked like a mat consisting of germinated seeds, white roots and green shoots and reached a height of about of 25–30 cm after 7 days. The size of the mat depends both on the type of grain and growth period, which is reported as 20–25 cm in 6 days in DU-3 cowpea (Naik *et al*. 2016c); 25–30 cm in 7 days in NB-4 cowpea (Naik *et al.* 2016d); and 20–30 cm in 7 days in maize (Naik *et al*. 2017b).

The fresh yield and DM content of the hydroponically sprouted Alsando increased ($P<0.05$) and decreased ($P<0.05$), respectively with the advancement of growing period and was highest (10.16 kg) and lowest (5.84%) at 10th day (Table 1). 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. The imbibition of water and enzymatic activities 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 the 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-day 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). 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). In cowpea (DU-3), there was 6.7 times increase in fresh weight with DM content of

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Table 1. Chemical composition (on % DM basis) of hydroponically sprouted Alsando

Nutrient	Days of growth in hydroponics greenhouse									SEM
	1	2	3	4	5	6	7	8	9	
Fresh yield (kg)/kg seed	3.92± 0.10^{a}	4.62± 0.04^{b}	5.59± 0.06^{c}	6.63± 0.05^{d}	7.91± 0.26^{e}	8.02± 0.18^{e}	8.94± 0.20^{f}	9.87± 0.20^{g}	10.16± 0.19^{g}	0.19
Dry matter (on % fresh basis)	46.90± 0.24^{h}	31.87± 0.09^{g}	22.95± 0.05^{f}	14.46± 0.09^{e}	9.97± 0.10^{d}	8.52± 0.33^{c}	7.57± 0.07^{b}	6.19± 0.0^{a}	5.84± 0.10^{a}	2.62
Crude protein*	22.48± 0.31^{a}	23.75± 0.34^{b}	24.09± 0.06^{b}	24.65± 0.15^{b}	28.07± 0.09^{c}	28.43± 0.29^{c}	29.54± 0.28^{d}	30.32± 0.28^{d}	30.32± 0.21^{d}	0.58
Ether extract*	1.36± 0.04^{a}	1.39± 0.03^{a}	1.49± 0.06^{ab}	1.56± 0.04^{ab}	1.61± 0.24^{ab}	1.61± 0.02^{ab}	1.61± 0.04^{ab}	1.63± 0.06^{ab}	1.84± 0.05^{b}	0.04
Crude fibre*	6.26± 0.16^{a}	6.59± 0.11^{a}	8.03± 0.40^{a}	8.83± 0.12^{a}	10.40± 0.69^{ab}	11.91± 0.41^{ab}	15.21± 0.21^{b}	21.64± 0.26^{c}	22.61± 3.50^{c}	1.19
Nitrogen free extract*	65.16± 0.44^{d}	63.51± 0.47^{d}	61.48± 0.40^{d}	59.94± 0.06^{d}	54.76± 0.80^{c}	52.70± 0.73^{bc}	48.16± 0.43^{b}	40.49± 0.35^{a}	39.03± 3.49^{a}	1.82
Total ash*	4.75± 0.03^{a}	4.76± 0.06^{a}	4.91± 0.01^{ab}	5.03± 0.03^{bc}	5.16± 0.05^{cd}	5.35± 0.07^{de}	5.48± 0.05^{e}	5.93± 0.04^{f}	6.20± 0.06^{g}	0.10
Acid insoluble ash*	0.70± 0.02^{a}	0.80± 0.01^{ab}	0.80± 0.05^{ab}	0.83± 0.01^{b}	0.86± 0.01^{b}	0.86± 0.03^{b}	0.87± 0.01^{b}	0.87± 0.02^{b}	0.90± 0.05^{b}	0.01

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

9.32% of the sprouted grains than the seed weight in 6 days (Naik *et al*. 2016c); while it was 6.63 times with DM content 6.49% in 9 days cowpea (NB-4) (Naik *et al*. 2016d). Naik and Singh (2014) reported that fresh yields of 3.5–6.0 folds with DM content of 11–14% are common in 7-8 days for hydroponically sprouted maize grains; however, sometimes DM content up to 18.3% was also observed (Naik *et al.* 2015, 2017b).

The CP% of the hydroponically sprouted Alsando was lowest ($P<0.05$) on the 1st day (22.48), then increased and remained similar during 7th (29.54)-9th (30.32) 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). Similar to this study, the CP% of the hydroponically sprouted cowpea (DU-3) in 6 days and cowpea (NB-4) in 9 days was 27.16 (Naik *et al*. 2016c) and 31.23 (Naik *et al*. 2016d), respectively.

The EE content increased and remained similar ($P>0.05$) during third day (1.49%) to ninth (1.84%) day of sprouting; which may be due to the increase in the structural lipids and production of chlorophyll associated with the plant growth. However, the EE% of the hydroponically sprouted cowpea (DU-3) in 6 days and cowpea (NB-4) in 9 days was respectively, 1.77 (Naik *et al*. 2016c) and 3.22 (Naik *et al*. 2016d); which was higher than the present study.

During sprouting, the CF% and NFE% had an increasing and decreasing trend; and was highest and lowest, respectively during eighth (21.64 and 40.49) and ninth day (22.61 and 39.03). 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 are reports of 11.86% CF in 6 days (Naik *et al.* 2016c) and 21.59% CF% in 9 days (Naik *et al.* 2016d) in the hydroponically sprouted DU-3 and NB-4 cowpea, respectively.

There was an increasing trend in the TA content of the hydroponically sprouted Alsando with the advancement of the period; which was lowest on first day (4.75) and highest (6.20) on ninth day. 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, the TA% of the hydroponically sprouted cowpea (DU-3) in 6 days and cowpea (NB-4) in 9 days was 4.44 (Naik *et al*. 2016c) and 5.38 (Naik *et al*. 2016d), respectively.

There are reports of sprouting of maize grains hydroponically for 7-8 days and have been used as feed supplement successfully for dairy animals (Naik *et al*. 2014, 2017b).

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

SUMMARY

Hydroponically sprouted Alsando (*Vigna unguiculata*) was produced daily for 15 days in a hydroponics chamber

(greenhouse) equipped with automatic sprayer irrigation of tap water. Alsando 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 d, after which it was harvested. The fresh yield (kg/kg seed) and DM content of the hydroponically sprouted Alsando increased and decreased with the growing period; and on ninth day, it was highest (10.16 kg) and lowest (5.84%), respectively. The CP% of the hydroponically sprouted Alsando was lowest on the first day (22.48), then increased and remained similar during seventh (29.54)-ninth (30.32) day sprouting period. The EE content increased and remained similar during third day (1.49%) to ninth (1.84%) day of sprouting. During sprouting, the CF% and NFE% had an increasing and decreasing trend; and was highest and lowest, respectively, during eighth (21.64 and 40.49) and ninth day (22.61 and 39.03). There was an increasing trend in the TA content of the hydroponically sprouted Alsando with the advancement of the period; which was lowest on first day (4.75) and highest (6.20) on ninth day. It can be concluded that based on the yield and different nutrient contents, Alsando can be sprouted hydroponically for 6-9 days to use as feed supplement for dairy animals.

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