Cost efficient nutrient solutions from commercially available fertilizers

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A variety of different nutrient solutions is described in the literature, such as the Murashige-Skoog medium, the Schenk-Hildebrandt medium, the Hoagland's medium, or the N medium (Appenroth 2015). In all these cases, they are based on expensive *pro analysi* (p.a.) chemicals with high purity, as they are usually used for small-scale laboratory purposes.

When duckweed is cultivated on a larger scale, much greater quantities of chemicals are needed for nutrient solution or stock solution preparation. Depending on the amount of chemicals needed, this can become very expensive, especially on an agricultural scale.

Therefore, a less expensive way of preparing the stock solutions for a modified N medium is described in the literature (Petersen et al. 2021) Exchanging p.a. chemicals with commercially available fertilizers can reduce the costs for duckweed growers.

At the University of Applied Sciences Osnabrück, Germany, a modified N medium with a nitrate-N to ammonium-N ratio of 75 % to 25 % is applied for duckweed cultivation (Table 1). The corresponding six stock solutions (stock solution 2 is not used for this ratio) are mainly prepared with commercially available fertilizers. The cost for one liter of stock solution is currently about 1.55 €. For nutrient solution preparation this stock solution will be diluted at least 1:200, giving a final cost of 0.009 € per liter, including the cost for local tap water.

Marked in red is the nitrate-N to ammonium-N ratio which resulted in the highest RGR (0.22 d^{-1}), crude protein content (43.9 %) and relative protein yield (45 g $week^{-1}$ m^{-2}) for the species *Wolffiella hyalina* (clone 9525). For cultivation, a water temperature of 20°C, a light intensity of 350 µmol m^{-2} s^{-1} and a photoperiod of 8:16 hours light to dark cycle was applied (Petersen et al. 2021).

Table 1: Formulation of seven stock solutions (g L^{-1}) for five different nitrate-N to ammonium-N ratios ([100-0], [75-25], [50-50], [25-75], and [0-100]), based on the N-medium. Marked in red color is the nitrate-N to ammonium-N ratio which resulted in highest RGR, crude protein content and relative protein yield (Petersen et al. 2021).

Stock solution	Product name	Producer	[100-0] (g L^{-1})	[75-25] (g L^{-1})	[50-50] (g L^{-1})	[25-75] (g L^{-1})	[0-100] (g L^{-1})
1	Calcinit	Yara	47.2	35.4	23.6	11.8	0
1	Krista K Plus	Yara	161.8	121.3	80.9	40.4	0
2	NH_4Cl	Merck	0	0	26.7	53.5	80.2
3	OCI Granular 2	OCI NV	0	33	33	33	33
4	KCl	AppliChem	0	29.8	59.6	89.5	119.3
4	$CaCl_2 * 2 H_20$	Merck	0	7.4	14.7	22.1	29.4
5	Krista MKP	Yara	27.2	27.2	27.2	27.2	27.2
6	Epso Combitop	K+S	49.3	49.3	49.3	49.3	49.3
6	Borax	Horticoop	0.06	0.06	0.06	0.06	0.06
6	Mangaan	Horticoop	0.44	0.44	0.44	0.44	0.44
6	$MoNa_2O_4 * 2 H_20$	AppliChem	0.02	0.02	0.02	0.02	0.02
7	Ferty 72	Planta	2.2	2.2	2.2	2.2	2.2

Such a described medium was also successfully used for other scientific experiments (Petersen et al. 2022).

References:

Appenroth, Klaus J. (2015): Media for in vitro-cultivation of duckweed. Duckweed Forum 3, 180–186.

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