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Concerns over the reporting of inconsistent data on fatty acid composition for microalgae of the genus *Nannochloropsis* (Eustigmatophyceae)

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Letter to editor
The current research focus on the development of next-generation alternative sources of biofuel from microalgal oil has led to a considerable increase in the number of studies on various oleaginous species. The studies have been examining species promising for high neutral lipid (mainly triacylglycerol; TAG) and biomass productivity under diverse cultivation conditions, with the aim to develop sustainable, commercially feasible, and economic processes for the production of biofuels (Rodolfi et al. 2009; Tredici 2010).

Given the relative robustness and marine origin of microalgae of the genus *Nannochloropsis* and their high content of neutral lipids (Sukenik 1999; Sukenik et al. 2009; Rodolfi et al. 2009), a large number of projects have been devoted to these microalgae, including studies focusing on evaluating the effects of growth conditions on lipid productivity and fatty acid composition (Boussiba et al. 1987; Chini Zittelli et al. 1999; Chiu et al. 2009; Hodgson et al. 1991; Renaud et al. 1991; Renaud and Parry 1994; Richmond et al. 2003; Sukenik 1999; Sukenik et al. 2009). *Nannochloropsis* species are also a valuable source of the ω3 long-chain polyunsaturated fatty acid, eicosapentaenoic acid (20:5n-3, EPA) for aquaculture and even for human nutrition. These eustigmatophytes are characterized by a typical fatty acid composition that features four abundant fatty acids (Table 1): palmitic (16:0), palmitoleic (16:1n-7), arachidonic acid (20:4n-6), and eicosapentaenoic acid (20:5n-3) (Sukenik 1999; Volkman et al. 1993). C18 fatty acids are represented mainly by oleic acid (18:1); unsaturated 18:2 and n-3 and n-6 isomers of 18:3 account for only a small portion of the total fatty acids, with the actual amounts depending on the growth conditions. Although the proportions of the major fatty acids vary under different cultivation conditions, their abundances are fairly consistent across the different strains and thus constitute a useful chemotaxonomic feature. Table 1 presents the well-established characteristic features of several well-studied strains of *N. salina* (strain CS-190) and three strains of *Nannochloropsis oculata* (CS-170, CS-179, and CS-216; data taken from Volkman et al. 1993; Renaud and Parry 1994).

We have noticed that a recent publication reports fatty acid composition data for *Nannochloropsis* cultures (Su et al. 2010) that are inconsistent with the above data in that it describes high relative percentages of 18:2 and 18:3(n-3) (Table 1). It is likely that the high proportions of these fatty acids are due to severe contamination of the cultures with green microalgae, typically rich in C18 PUFA. Moreover, the marked increase in the proportion of oleic acid 18:1(n-9) and disappearance of 16:1(n-7) under nitrogen starvation conditions further indicates the enhanced formation of storage TAG in cells of the contaminating algae but not in *N. oculata*. Characteristically, TAG of *Nannochloropsis* species are rich in 16:0 and 16:1(n-7) fatty acids (Sukenik 1999); their combined proportions increase up to 70–80% of total fatty acids under stress conditions, such as nitrogen starvation or high light intensity (Pal, Khozin-Goldberg, Boussiba, unpublished), while 18:1 accounts for about 10% of total fatty acids.

Results for biomass and lipid productivity that are obtained in the cultures featuring fatty acid profile

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Table 1 Major fatty acid composition (percentage of total fatty acids) of selected *Nannochloropsis* strains (for cultivation conditions refer to Volkman et al. 1993; Renaud and Parry 1994; Su et al. 2010)

Fatty acid	Volkman et al. (1993)[a]		Renaud and Parry (1994)[b]		Su et al. (2010)[c]	
	N. salina CS-190	*N. oculata* CS-216	*N. oculata* CS-179	*N. oculata* CS-170	*N. oculata* day 0	*N. oculata* day 4 (−N)
Saturated fatty acids						
14:0	5.0	3.3	4.6	5.4	8.0	nd
16:0	27.8	17.8	14.2	26.0	25.5	26.9
18:0	1.0	0.9	0.6	1.2	6.6	7.2
Monounsaturated fatty acids						
16:l(n-7)	31.8	26.6	29.4	22.0	6.6	nd
18:1(n-9)	8.3	7.7	6.3	5.8	13.3	36.8
Polyunsaturated fatty acids						
18:2(n-6)	1.5	2.9	2.0	3.3	18.5	16.0
18:3(n-6)	0.4	0.3	0.3	0.4	nd	nd
18:3(n-3)	0.2	0.4	0.1	1.0	12.6	3.2
20:3(n-6)	0.9	0.2	0.4	nd	nd	nd
20:4(n-6)	4.0	7.1	8.8	5.5	nd	nd
20:5(n-3)	24.2	28.4	28.8	24.9	13.6	7.4

[a]Cells harvested at mid or late log phase

[b]Cells harvested at late log phase

[c]Strain was obtained from Fisheries Research Institute, Taiwan

day 0 initial conditions, nitrogen replete culture; *–N* nitrogen starvation conditions, *nd* not determined or data not provided

contradictory to commonly found profiles could be misleading since the findings are likely to be skewed by the contribution of the invader algae. Careful microscopic inspection of the cultures, along with a critical analysis of fatty acid data, are the compulsory prerequisites for publications on lipid productivity of microalgae.

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