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E. Manzocchi[1], B. Guggenbühl[2], M. Kreuzer[1] and K. Giller[1]
[1]ETH Zürich, Institute of Agricultural Sciences, Animal Nutrition, Zurich, Switzerland; [2]Federal Department of Economic Affairs, Education and Research, Agroscope, Food Microbial Systems, Bern, Switzerland
Email: katrin.giller@usys.ethz.ch

Introduction There is a search for alternative protein sources produced on non-arable land to be able to replace the critically discussed but extensively used soybean meal in diets of livestock. The cyanobacterium Spirulina (*Arthrospira platensis*), often associated with the group of microalgae, is an interesting option due to its low growth requirements. By replacing soybean meal with Spirulina, more arable land would remain available for human food production. In addition to its high protein content, Spirulina contains high proportions of nutritionally favourable fatty acids and might thereby potentially improve the nutritional quality of milk for consumers. So far, only very few studies have evaluated the effects of feeding Spirulina to dairy cows and its effects on milk quality. Therefore, the present study aimed at investigating the effects of replacing soybean meal with Spirulina in dairy cows on compositional and sensory quality aspects as well as on coagulation properties of the milk.

Materials and Methods Twelve late-lactating dairy cows (6 Brown Swiss and 6 Holstein; 2±1 lactations, 329±69 days in milk) were housed in a single pen within a free-stall barn and randomly allocated (considering breed, parity and milk yield) to one of two experimental groups. Applying electronic access control, each animal had *ad libitum* access to only one individual feeding trough. One group (SOY; n=6) was fed with a total mixed ration consisting, on a dry matter (DM) basis, of 74% hay (18.7% crude protein (CP)/kg DM), 13% sugar beet pulp, 6% soybean meal (47.8% CP kg DM), 4% wheat flakes and 3% molasses. For the second group (SPI; n=6), the soybean meal in that diet was replaced by 5% dried powdery Spirulina meal (67.6% CP/kg DM) and 1% wheat flakes. Ingredients were homogenously mixed in order to avoid feed selection. The diets were isoenergetic (5.3 MJ/kg DM) and isonitrogenous (20 g N/kg DM). In addition, the cows received NaCl (50 g/d) and a vitaminized mineral mix (120 g/d). The cows were allowed to adapt for 2 weeks to the diet. After this adaption period, 3 weeks of sampling followed, where feed intake and milk yield were recorded daily. At each milking, milk samples were collected and pooled per day according to milk yield. Analysis of milk composition was performed by mid infrared spectroscopy (MilkoScan FT1, Foss, Hilleroed, Denmark). Rennet coagulation properties were determined twice in the sampling period with a Lattodinamografo (Foss, Padua, Italy). The milk color was determined four times during the sampling period using a tristimulus colorimeter (Chroma-Meter CR-300, Minolta, Osaka, Japan). In addition, complete milkings from all cows were collected two times on two consecutive days. For standardization of the fat content, the milkings of two cows each were combined to result in three milk mixtures per experimental group. The resulting total 12 milk mixtures were then individually homogenized and pasteurized and subsequently evaluated in 15 triangle tests by a sensory panel trained on milk products. Data were analysed with the Mixed procedure of SAS considering diet, breed, and their interaction as fixed factors. Milk composition data from before the start of the experiment were included as covariate.

Results The complete replacement of soybean meal with Spirulina did not affect the DM intake (means ± SEM; SPI 17.6 vs. SOY 17.2 ± 0.9 kg DM/day; P=0.8), which points to a high palatability of Spirulina for dairy cows. Moreover, the milk yield (SPI 18.1 vs. SOY 16.7 ± 0.8 kg/day; P=0.2) and the milk composition as well as the rennet coagulation properties (rennet coagulation time, rate of firming and curd firmness) were also not affected (all P>0.1). However, the milk from Spirulina-fed cows had a higher (P=0.013) yellowness (b*, SPI 14.9 vs. SOY 13.8 ± 0.2) at unchanged brightness (L*, SPI 75.1 vs. SOY 75.1 ± 0.2; P=1.0) and redness (a*, SPI -5.65 vs. SOY -5.65 ± 0.1; P=1.0). This was probably caused by the transfer of abundant pigments, especially carotenes and xanthophylls, from Spirulina. In case a higher amount of the vitamin A precursor β-carotene is indeed confirmed by the ongoing analyses, Spirulina might be additionally valuable for cows and consumers from a nutritional perspective. Furthermore, an increased carotenoid content in the lipid fraction of the milk from Spirulina-fed dairy cows might improve its oxidative stability and therefore its shelf life. With regard to the sensory evaluation, 12 of the 15 triangle tests with 13 to 17 panellists did not show any significant difference between the two milk types. This emphasizes that feeding Spirulina did not impair milk flavor.

Conclusions Our study shows that Spirulina can completely replace soybean meal in the diet of dairy cows without impairing feed intake as well as milk yield, composition and coagulation properties. Milk flavor also does not seem to be negatively affected. In order to provide a more in depth characterization of the milk nutritional properties, further analysis such as milk carotenoid and fatty acid profiling and determination of antioxidant properties are still ongoing.

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