

Improvements in agricultural practices and livestock diet enhance the nutritional quality of women's breast milk: a "One Health" randomized, clinical trial

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Abstract

Introduction. An increase in n-3 polyunsaturated fatty acids (PUFAs) in women's dietary intake could alter the quality of their breast milk. We previously established that changing agricultural and livestock-feeding practices resulted in an increase in n-3 PUFAs content in usual human food products, while reducing the agricultural environmental footprint. The "Bleu-Blanc-Coeur" (BBC)[®] food chain is an example of the 'One Health' approach. The study objectives were to evaluate whether intake of BBC products during pregnancy and lactation increased the alpha linolenic acid (ALA) content of breast milk on day (d) 21 postpartum (PP) (primary), and altered the complete fatty acid (FA) and lipidomic profiles, the human milk oligosaccharides (HMOs) and the hormones and immune markers in the composition of breast milk, at d21 and 45-PP, as well as the intestinal microbiota of neonates at d21-PP (secondary).

Volunteers and methods. In a single-centre, interventional, randomized, open-label study, women who had received the standardized dietary advice during pregnancy, substituted (BBC group) or did not substitute (control group, CTRL) their usual food products with BBC products from the 7th month of pregnancy until d45-PP, without changing their eating habits. The calculation of the required sample size was n=40 women /group. The main inclusion criteria were: adult women, ≤ 28 weeks of amenorrhea, with the intention to breastfeed exclusively until at least d45-PP. Maternal blood (at inclusion (d0) and d21-PP) and milk (at d21-PP and d45-PP) were collected. ALA content in the breast milk at d21-PP was the primary endpoint. Food consumption, FA profile in breast milk and red blood cells (RBCs), lipidomic profile, hormones (insulin, leptin, adiponectin), and immune markers (interleukin (IL)-6, lactoferrin, immunoglobulin (Ig) A and G) levels in breast milk (d21 and d45-PP), as well as HMO profile in breast milk (d21-PP), and the faecal microbiota composition of neonates (d21-PP) were analysed as secondary endpoints.

Results. Of the 66 women included and randomized, 58 were analysed: BBC, n=28, CTRL, n=30: mean age (\pm SD), 31.4 \pm 3.7 years, gestational age, 25.5 \pm 2.1 weeks, body mass index, 24.6 \pm 3.2. There was no significant difference between the two groups across these parameters, nor was there in their medical history, eating habits or FA content in RBC at inclusion. During the intervention, the mothers' ALA intake was 160% higher in the BBC group than in the CTRL group. In breast milk, at d21-PP and d45-PP, ALA levels (1.05 (quartiles 1-3, 0.74-1.26) vs. 0.60 (0.45-0.79) % of total FA content (% FA) (P <0.001) at d21-PP, 1.02 ((0.88-1.38) vs. 0.74 (0.58-1.10) % FA (P <0.001) at d45-PP were respectively higher in the BBC group than in the CTRL group. The same was observed for total n-3 PUFA levels (1.44 (1.18-1.83) vs. 0.95 (0.63-1.37) % FA (P =0.004) at d21-PP, 1.45 (1.16-1.83) vs. 1.19 (0.87-1.75) % FA (P =0.004) at d45-PP). In the RBCs, at d21-PP, no difference in FA content was observed, except for monounsaturated FA, lower in the BBC group than in the CTRL group (P =0.02).

At d21-PP, in comparison with milk from the CTRL group, the BBC breast milk lipidome presented a higher content in the total saturated, mono- and polyunsaturated FA-containing diglycerides, and higher levels of three major triglycerides containing ALA and one minor plasmalogen phosphatidylethanolamine containing docosahexaenoic acid. Breast milk insulin levels were higher (P =0.047) in the BBC group than in the CTRL group at both d21-PP and d45-PP. Leptin, adiponectin, lactoferrin and IgA content in milk did not differ. IgG milk content tended to be higher in the BBC group than in the CTRL group (P =0.08) at both d21 and d45-PP, while IL-6 content in milk decreased between d21-PP and d45-PP in the CTRL group but not in the BBC group (group x stage of lactation interaction P =0.01). In the Secretor gene (Se)⁺ Lewis gene (Le)⁺ serologic group, accounting for 74% of the women, total HMO content was similar between the two groups (respectively 10.8 and 10.4 g/l). However, specific fucosylated HMO levels, including 2-fucosyl-lactose and monofucosyllacto-N-hexaose III, differed significantly: while 2-fucosyl-lactose was

significantly lower in the BBC group than in the CTRL group ($P=0.006$), monofucosyllacto-N-hexaose III was higher ($P=0.004$). Additionally, two isomers of difucosyllacto-N-octaose and one of trifucosyllacto-N-octaose were higher in the BBC milk than in the CTRL milk ($P=0.032$, 0.032 and 0.024 respectively). The alpha-diversity (number of species) of the faecal microbiota of neonates at d21-PP was greater ($P=0.048$) in the BBC group than in the CTRL group.

Conclusion. A diet covering the needs for n-3 PUFAs, including ALA, by resorting to BBC® products increases the levels of these components in breast milk among lactating women. This diet induces differences in hormonal and immune markers of milk, with some lipid species enriched in PUFAs, and specific HMO concentrations, as well as in the faecal microbiota of neonates. Thus, for the first time in a randomized human clinical trial, our study provides evidence to support the fact that changing agricultural practices to improve human food quality benefits both the environment and human dietary patterns, illustrating the potential health benefits of the ‘One Health’ concept.

Keywords: breastfeeding; lactation; fatty acid composition; agricultural practices.