

Effect of Milk Fat Globules on metabolism and post-natal growth of rats

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Introduction

Milk Fat Globules (MFG) are unique structure which contain the milk fat. The MFG is secreted into milk by pinocytosis, which results in a trilayer of proteins and polar lipids enveloping the triglyceride core of the MFG and termed MFG membrane (MFGM)¹. MFG size range from 200 nm to over 15 µm and the size is tightly associated with the reative content of the MFGM. Recent studies highlight that the MFGM has diverse roles in regulating metabolism, health and development of neonates and adults alike. For example: decreased rates of gut infection in infants, as well as improved microbiome as manifested by reduced gut colonization of *Listeria* strain in adult rats².

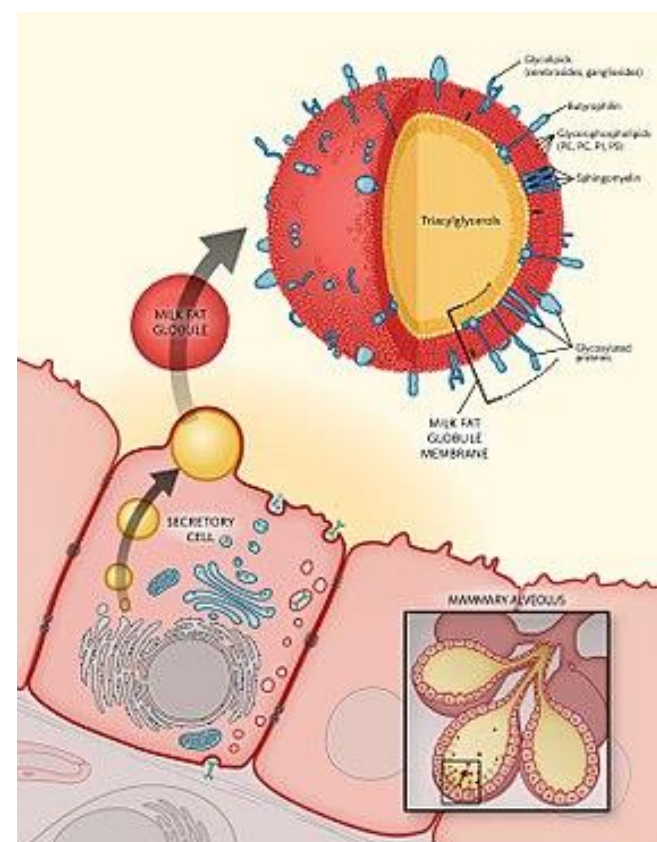


Figure 1: MFGs secretion in the milk producing cells.

Bone growth is the characteristic phenomena of the childhood period that serve as the best indicator for health and wellbeing, which is heavily influenced by the diet and nutritional status. It was recently shown that the microbiota of juvenile mice sustains both weight gain and linear growth and that the microbiota interact with the hormonal somatotrophic (GH/IGF1) axis activity to drive bone growth and bone mass³.

The objective of this research is to examine whether MFGs and their size affect skeletal development and metabolism in young rats.

Research Model

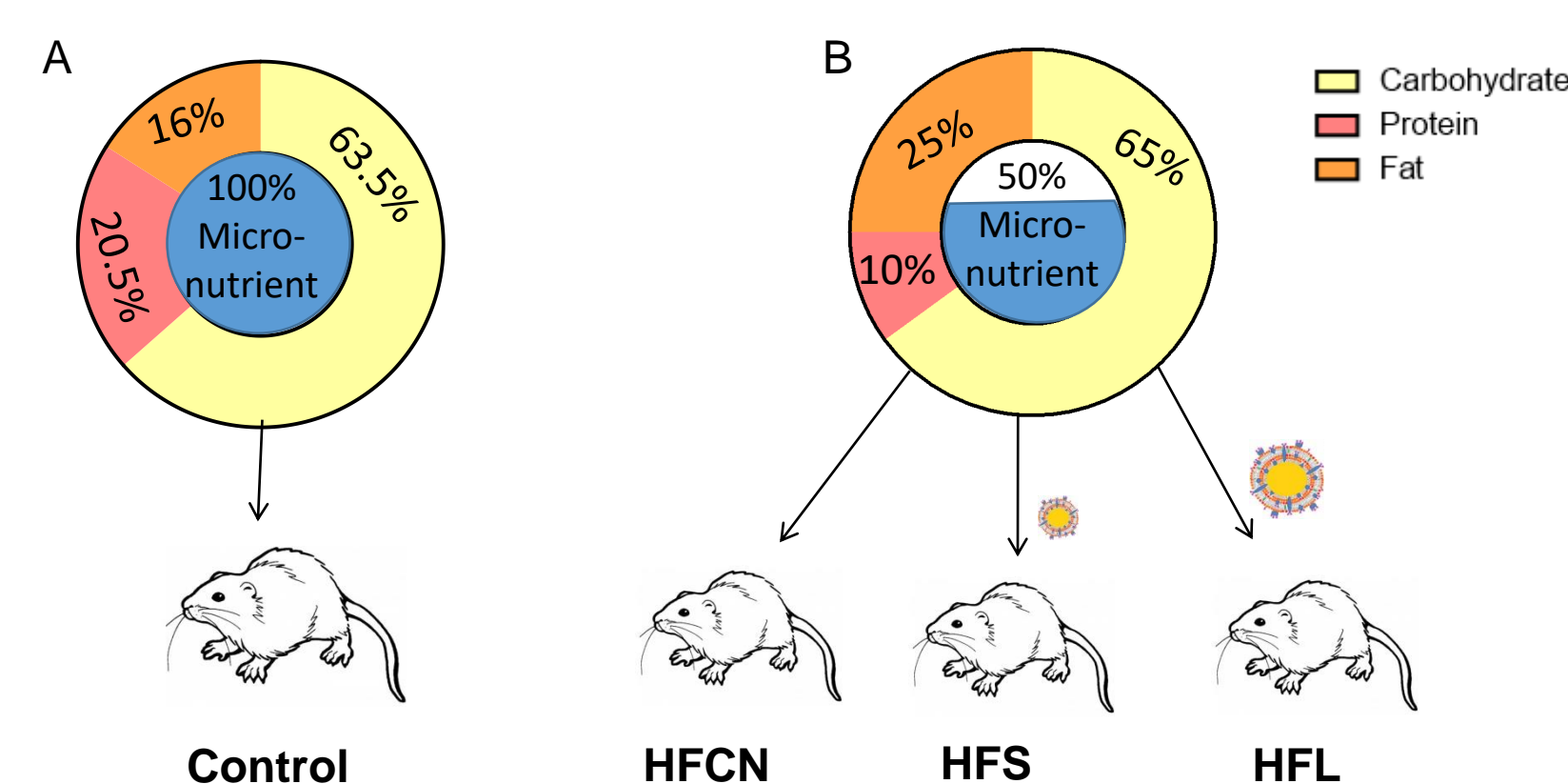


Figure 2. 3 weeks old female Sprague-Dawley rats were divided into 4 groups. For 6 weeks the rats were fed diets that differ in their amount of micro and macro nutrient. (A) Control group, Receiving recommended diet based on American Institute of Nutrition (AIN- 93) recommendations. (B) Experimental groups Divided into 3 groups. Receiving high fat and low protein, vitamin and mineral diet, mimicking the "western diet". 2 groups were supplemented with MFGs, small MFGs for the first and large MFGs for the second. HFCN, high fat control; HFS, high fat small; HFL, high fat large.

Fatty acids composition in the diet

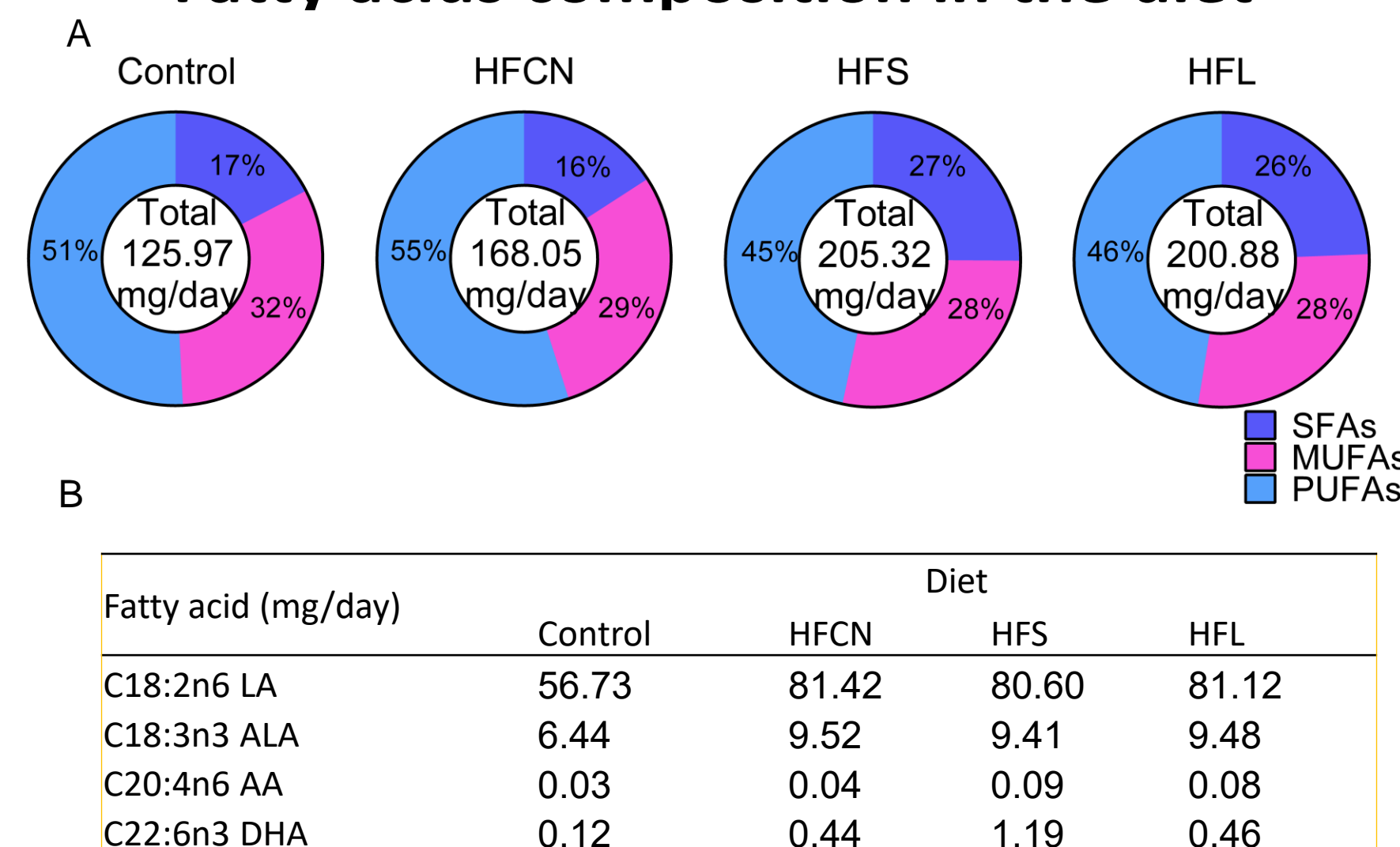


Figure 3. FAs profile of the diets, analyzed by gas chromatography, shows the differences in FAs composition between the diets including the MFGs supplementation. (A) FAs profile of the diet. (B) Diet quantity of C18:2 n6, C18:3 n3, C20:4 n6 and C22:6 n3. SFA, saturated fatty acid; MUFA, mono unsaturated fatty acid; PUFA, poly unsaturated fatty acids. LA, linoleic acid; ALA, alpha linolenic acid; AA, arachidonic acid; DHA, docosahexaenoic acid

Composition of fatty acids in serum

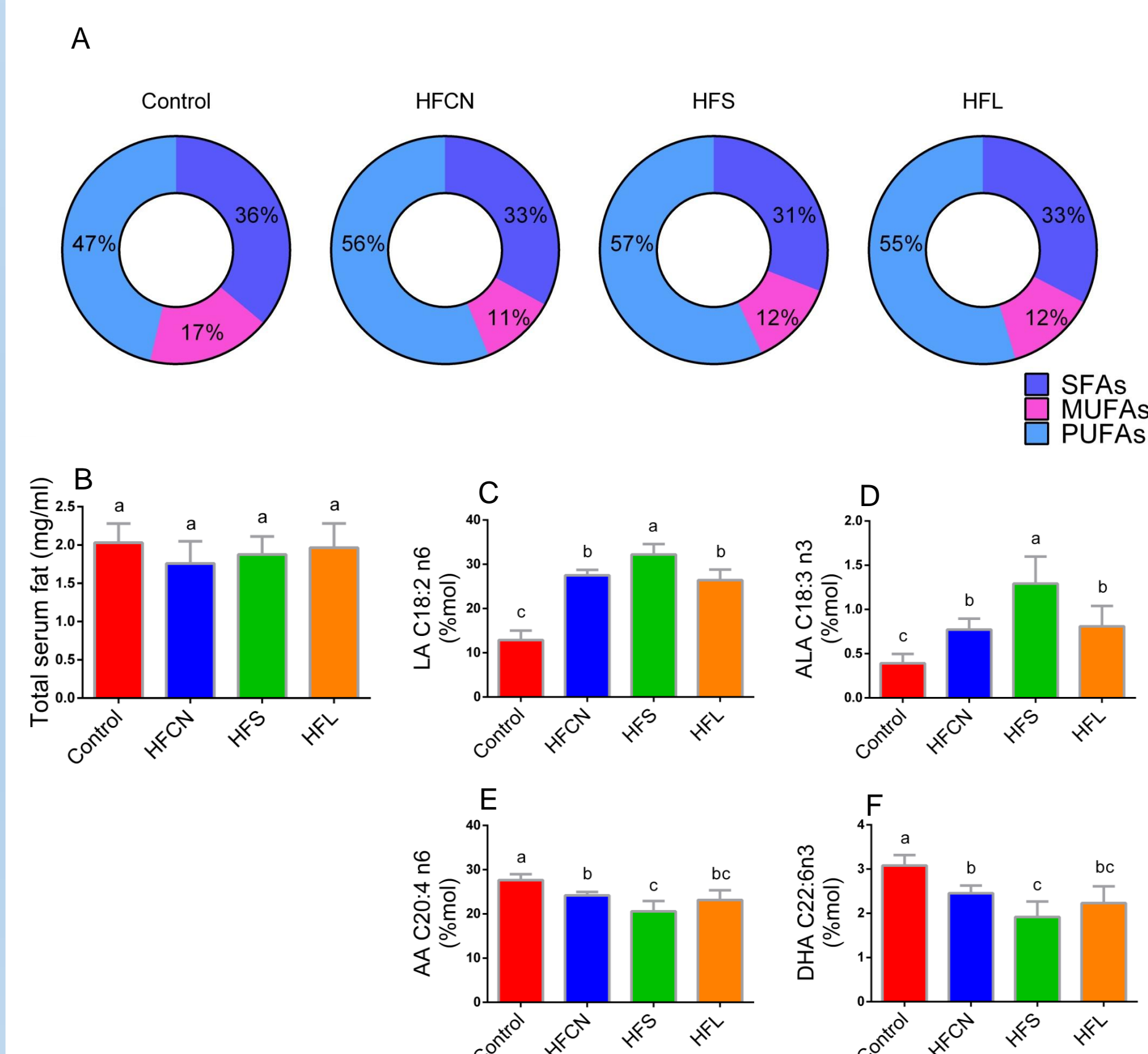


Figure 4. Lipids were extracted from serum samples and FAs composition was analyzed by gas chromatography. (A) FAs profile of the serum. (B) Serum total FAs (C) Serum %mol of C18:2 n6. (D) Serum %mol of C18:3 n3. (E) Serum %mol of C20:4 n6. (F) Serum %mol of C22:6 n3.

Results

MFGs does not affect growth pattern in High Fat diet

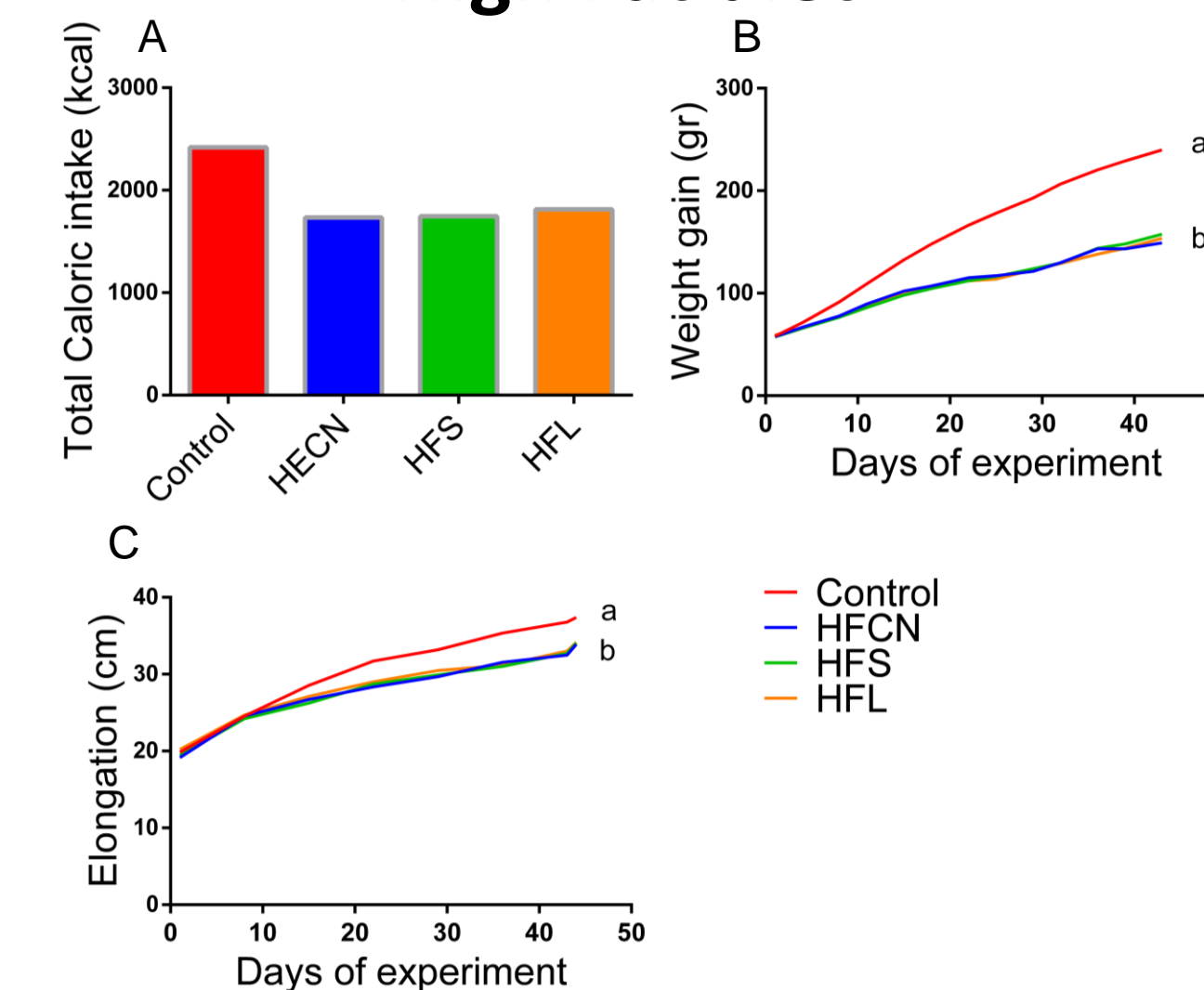


Figure 5. Throughout the experiment body mass and food intake were measured twice a week. Additionally, tail length was measured once a week. (A) Food intake (gr/mouse) (B) Weight during the entire experiment (gr). (C) Longitudinal growth during the entire experiment.

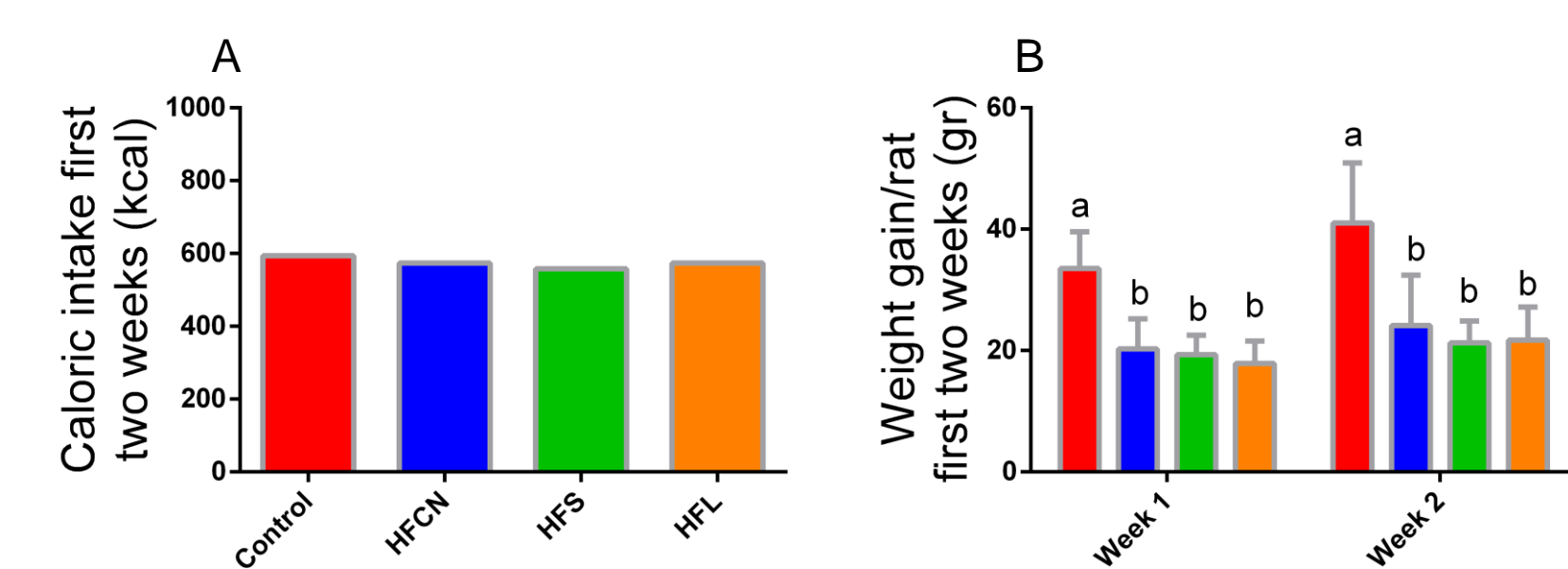


Figure 6. (A) Total caloric intake in first two weeks. (B) Total weight gain in first and second week.

Small MFGs improve protein efficiency for growth in High Fat diet

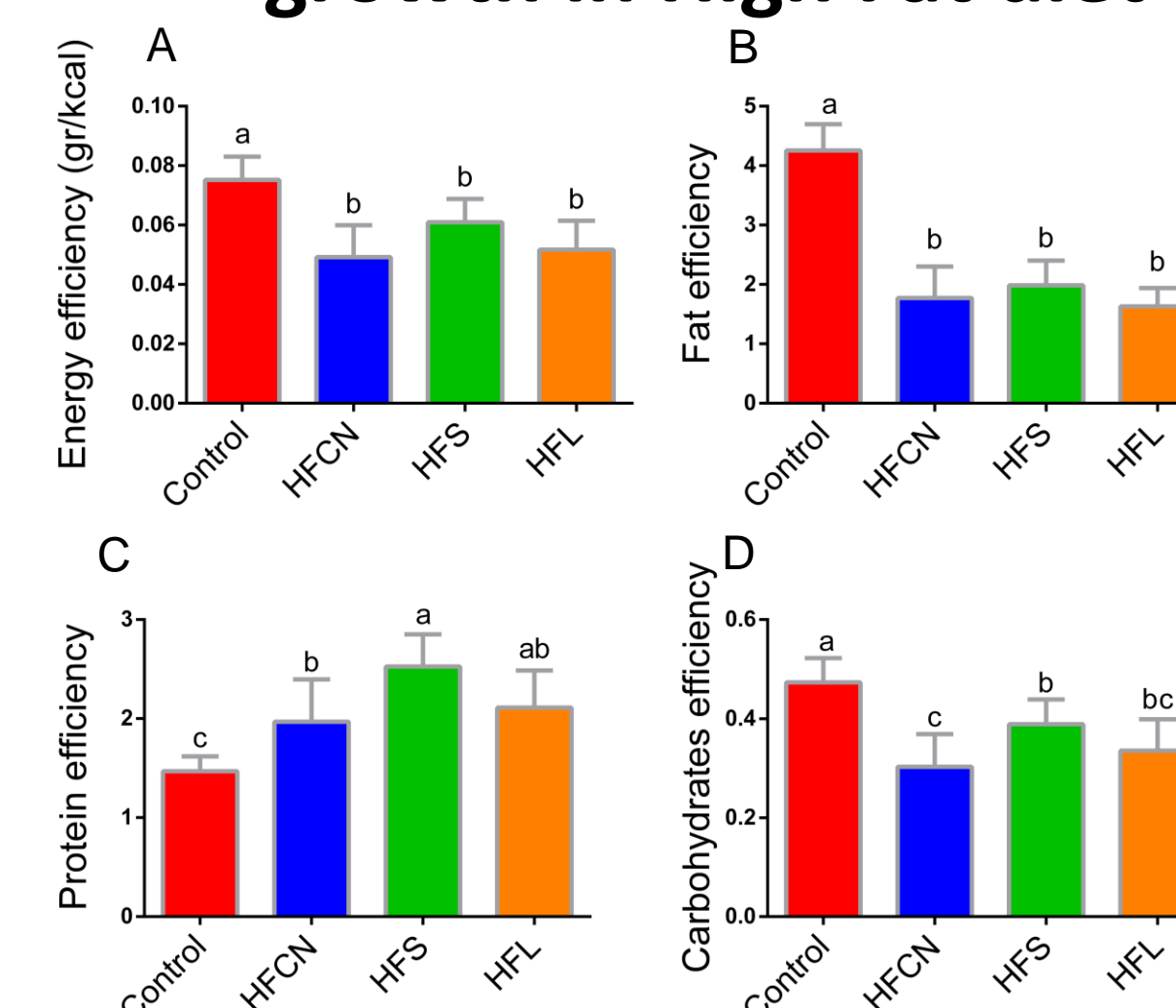


Figure 7. Food efficiency was calculated as total body weight gain in the experiment/total food consumption. (A) Energy efficiency (gr body weight/kcal). (B) Fat efficiency (gr body weight/gr fat intake). (C) Protein efficiency (gr body weight/gr protein intake). (D) Carbohydrates efficiency (gr body weight/gr carbs intake).

Small MFGs improve trabecular parameters in High Fat diet

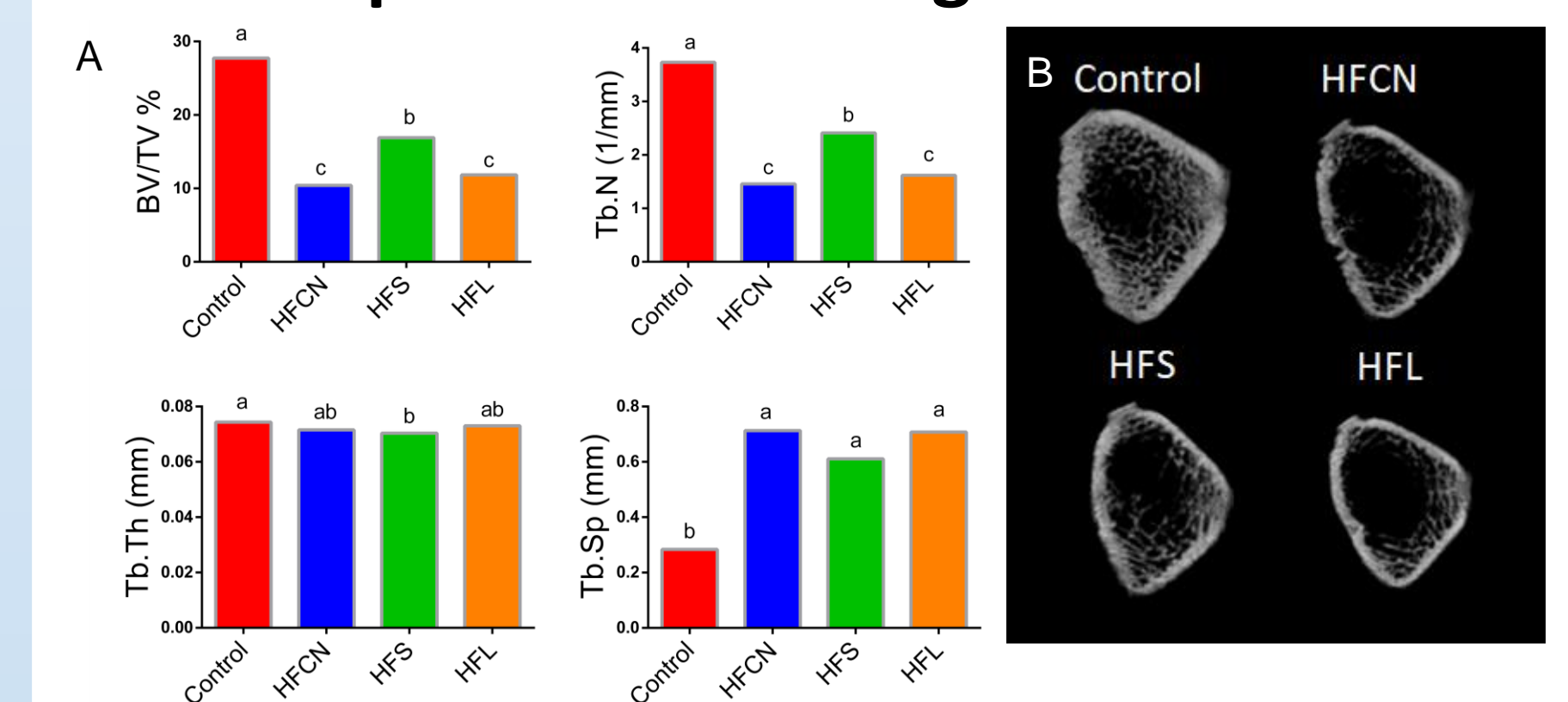


Figure 8. Right femurs were scanned by micro-computed tomography (CT) for determination of geometric parameters. After reconstructing, 2D and 3D analysis were performed. (A) Trabecular bone parameters: bone volume over total volume (BV/TV %), trabecular thickness (Tb.Th), trabecular number (Tb.N) and trabecular separation (Tb.Sp). (B) Image of trabecular bone by Amira software.

Conclusions

This research suggests that diet deficient in protein and micronutrients but not in its energy value, inhibit growth during the childhood and adolescence.

supplementation of small MFGs improve protein efficiency for growth and femur bone architecture in high fat and low protein and micronutrients diet.

In addition, supplementation of small MFGs affect the pathways of n-6 and n-3 FAs biosynthesis.

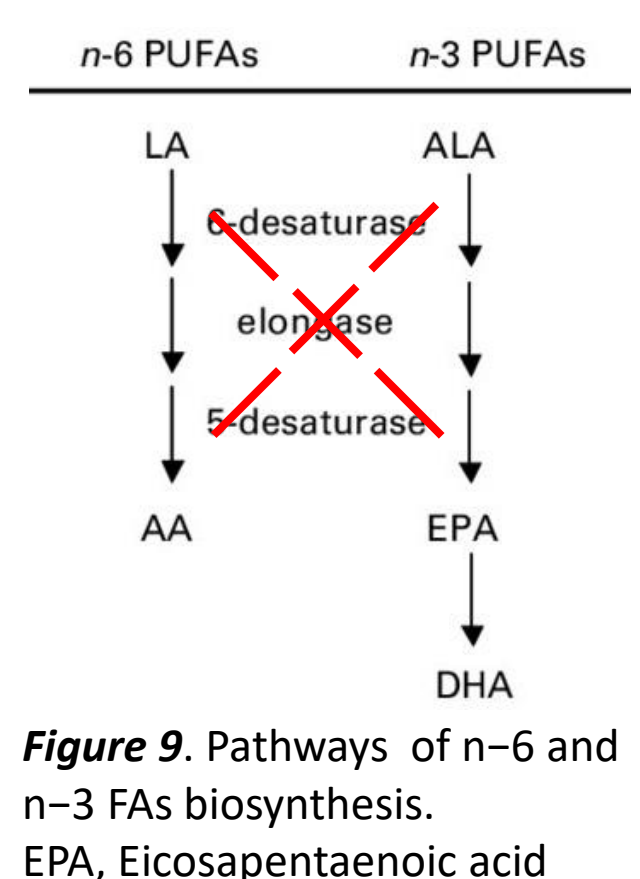


Figure 9. Pathways of n-6 and n-3 FAs biosynthesis. EPA, Eicosapentaenoic acid

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References:

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3. Hernandez, C.J., Guss, J.D., Luna, M. & Goldring, S.R. (2016) Links Between the Microbiome and Bone. *Journal of Bone Research*.