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Different Effects of Soy and Whey on Linear Bone Growth and Growth Pattern in Young Male Sprague-Dawley Rats

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INTRODUCTION

The most effective environmental factor that affects longitudinal growth is nutrition, but the exact composition and the relative benefits of specific dietary proteins in supporting linear growth is unknown. A study conducted in 105 countries found that protein intake from milk products, followed by animal protein, emerged as the most significant nutritional correlates of stature. In addition, plant based diets were not able to provide the optimal stimuli for physical growth[1] .

The use of plant-based protein isolates in food formulations has become a focus of interest due to greater sustainability, lower production costs, and a lower ecological footprint in addition to health and ideological reasons.

Our recent studies showed that specific nutrients can dramatically affect growth[2,3]. We therefore examined Whey (milk proteins) and Soy (plant based proteins) proteins as both contain all essential amino acids and are considered the best proteins in their categories according to the protein digestibility-corrected amino acids score (PDCAAS).

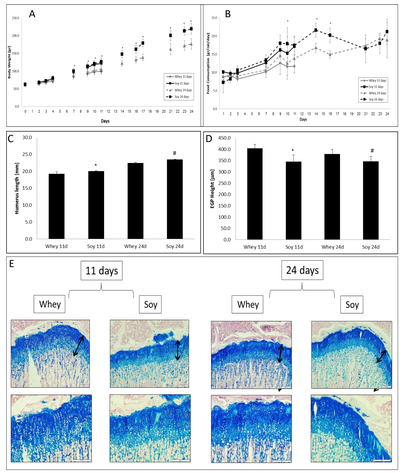
AIM

The aim of this study was to check the effect of the dietary proteins Whey and Soy on linear growth and bone structure

METHODS

- Young male Sprague Dawley rats were fed with either Whey or Soy based diets (28% protein of total calories and matched for calories, macro- and micro-nutrients).
- Rats were monitored for 11, 24 or 74 days in an *Ad Libitum* protocol or a Pair-fed protocol for 24 days.
- At sacrifice, humeri length and Epiphyseal Growth Plate (EGP) height and organization were measured.
- For safety, whole blood was drawn to assess total blood chemistry, Glucose Tolerance Test (GTT) and fasting glucose (data not shown) and also IGF-I levels.
- μCT analysis was used to determine the quality of the formed bone.

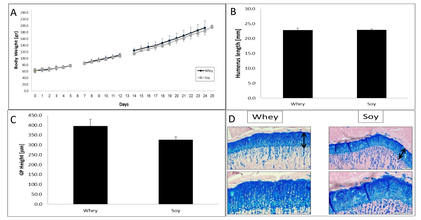
1. Effect of Whey vs. Soy on Linear Growth (11 and 24 days Ad Libitum (AL) Feeding)



Weight gain (A) and Humerus length (C) of the soy-fed rats was greater compared to the whey-fed rats in both experiments. Food consumption (C) of the soy group was greater until day 16 of the experiment after which the difference between the two groups diminished considerably. However, EGP height (D+E) was greater in sections taken from the whey-fed animals

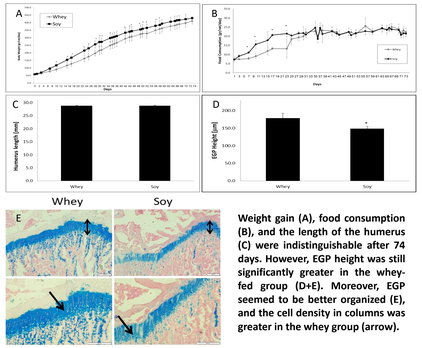
Two experiments were performed to determine if the different effect on growth was due solely to the difference in food consumption

2. Pair-fed experiment (24 days AL feeding)



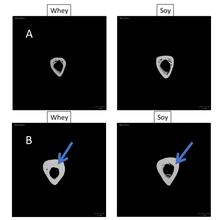
These results show that when there were no differences in food consumption, the effect on weight gain (A) and humerus length was diminished. However, EGP height (C+D) was still greater in the Whey fed group.

3. Long Term experiment (74 days AL feeding)



Weight gain (A), food consumption (B), and the length of the humerus (C) were indistinguishable after 74 days. However, EGP height was still significantly greater in the whey-fed group (D+E). Moreover, EGP seemed to be better organized (E), and the cell density in columns was greater in the whey group (arrow).

4. Bone microstructure analysis (µCT)

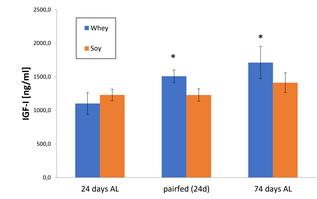


Three-dimensional cortical bone images obtained by µCT at 24 days (A) indicate greater diaphyseal diameter in the Soy group which was no longer different between the groups at 74 days (B). Moreover, at 74 days, the cortical thickness was greater at the Whey fed group (arrow)

	Whey 24d (n=6)	Soy 24d (n=6)	*p* value Soy vs Whey	Whey 74d (n=7)	Soy 74d (n=8)	*p* value Soy vs. Whey
(A) Full humerus length (mm)	22.55±0.38	23.55±0.37	P=0.001	28.37±0.7	28.59±0.37	P=0.49
% BV/TV	70±6	65±5	P=0.14	71±1	66±1	P=0.02
Volumetric bone mineral density (vBMD) (%)	354.57±74.48	367.73±56.58	P=0.74	651.98±19.22	586.08±37.53	P=0.011
(B) Cortical bone parameters						
Tt.Ar (mm^2)	3.88±0.23	4.46±0.38	P=0.012	6.04±0.5	5.85±0.58	P=0.49
Ct.Ar (mm^2)	2.46±0.63	2.99±0.47	P=0.13	4.7±0.33	4.19±0.36	P=0.017
Ct.Ar/Tt.Ar	0.63±0.14	0.67±0.09	P=0.56	0.78±0.03	0.72±0.02	P=0.001
Ct.Th (mm)	0.4±0.16	0.47±0.12	P=0.4	0.65±0.02	0.59±0.04	P=0.007
Dia.Dia (mm)	2.22±0.07	2.38±0.1	P=0.01	2.77±0.11	2.73±0.14	P=0.49
Med.Dia (mm)	1.33±0.23	1.36±0.18	P=0.805	1.3±0.12	1.45±0.11	P=0.03

Bone microstructure parameters (µCT) in male Sprague-Dawley rats after 24 or 74 days showed that while some parameters were better in the soy group at the end of the short-term experiment, the whey group corrected most parameters of bone structure over time, leading to the same length and partially better cortical bone parameters.

5. IGF-I serum levels



Serum IGF-I levels , were not significantly different between the groups at the end of the 24 days experiment, however they were significantly greater in the whey group in the pair-fed experiment and at 74 days. IGF-I increased over time (i.e., with age) only in the whey group (p<0.001) and not in the soy (data not shown)
***P<0.05**

CONCLUSIONS

In this study we wanted to determine the better protein for supporting optimal linear growth. Indeed, we found that use of different proteins had a differential effect on the growth pattern. Accelerated growth (weight gain and humerus length) in the short term experiments observed in the soy group was no longer present in the long term experiments.
Bone mineralization was greater in the whey group in the long term experiments.
A higher and better-organized EGP in the Whey groups throughout all the experiments was found and may indicate better growth potential. There was no indication for metabolic disturbance in either group. All values were in the normal range.
IGF-I levels were not significantly different between the groups at the end of the short-term experiments, however when there were no differences in food consumption, serum levels of IGF-1 were significantly greater in the whey group.
To conclude, the growth pattern of young rats fed iso-calorie iso-protein content diets were significantly affected by the identity of the protein.
As Soy led to a more robust growth and whey led to greater EGP, it may be possible that protein blends will provide the benefits of the better of the two worlds.

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