Journal of Neonatal Biology
ISSN: 2167-0897

Tomaszewska et al., J Neonatal Biol 2015, 4:3
DOI: 10.4172/2167-0897.1000183

Research Article Open Access

Maternal Nutrition with B-Hydroxy-B-Methylbutyrate as Strong Determinants of the Development of Newborn Offspring in Pigs

Ewa Tomaszewska[1]*, Piotr Dobrowolski[2], Monika Hułas-Stasiak[2] and Agnieszka Tomczyk[1]

[1]*Department of Animal Physiology, Faculty of Veterinary Medicine, University of Life Sciences in Lublin, Lublin, Poland*
[2]*Department of Comparative Anatomy and Anthropology, Maria Curie-Skłodowska University, Lublin, Poland*

Abstract

Aim: Interferences into maternal nutrient are used in studies related to prenatal programming - permanent changes in homeostasis of regulatory physiological mechanisms. Thus, the effect of HMB (β-Hydroxy-β-methylbutyrate) maternal administration on body characteristic in newborn offspring was studied.

Methods: Sows were fed with a standard diet and diet supplemented with HMB (0.2 mg/kg of body weight/ every day) in the morning meals from 70th to 90th day of gestation. Twenty four newborn piglets were weight and euthanized, organ weights were recorded. Moreover, changes in the somatotropin axis were assessed by determination of insulin-like growth factor 1.

Results: Maternal HMB supplementation significantly affected weight at birth. The weight of the liver was increased by 160% in the HMB piglets ($P < 0.01$) compared with Cont piglets, and the spleen was 67% heavier in HMB piglets ($P < 0.01$). The weight of the kidneys, lungs, heart and stomach was increased for the HMB piglets by 55%, 115%, 56% and 63%; whereas the weights of brain not affected by HMB supplementation. The concentration of IGF 1 also increased after maternal HMB supplementation (by 214%).

Conclusion: The study showed that maternal HMB supplementation in middle gestation had marked effects on characteristics of the newborn offspring.

Keywords: β-Hydroxy-β-methylbutyrate; Piglets; Postnatal development

Introduction

Adaptive, functional, structural and metabolic changes appearing during prenatal development as an effect of interaction between genes and environmental factors play dual function. They enhance the chance of newborns survival under suboptimal conditions during prenatal time and influence postnatal development. Changes of physiological processes of the prenatal development influence postnatal growth and adaptive possibilities of organism. Developmental alterations depend on the phase of development, genetic sensitivity of foetus and the condition of the pregnant [1-4]. The moment of the action of factors determines a type of alterations, because each organ has its own critical period, when its development may be changed. Interferences into maternal nutrient are used in studies related to prenatal programming - permanent changes in homeostasis of regulatory physiological mechanisms [5].

The positive impact of specific compounds in food is evident. Among these specific compounds, there is the bioactive metabolite of leucine (HMB, β-Hydroxy-β-methylbutyrate). Approximately 5% of leucine metabolism leads to endogenous synthesis of HMB, which serves as a key carbon source for *de novo* cholesterol synthesis in tissues, which is necessary to maintain maximal cell function [6-8]. Earlier studies on rats have shown that dietary supplementation with HMB results in enhanced wound collagen deposition. Similar results were obtained in another study on humans, where HMB administration enhanced the hydroxyproline content, thereby increasing wound repair processes [9]. Nutritional elements can influence bone metabolism and intestinal development [10]. Maternal administration with HMB has positive long-term effects on the skeletal system in offspring improving bone mineral density as well as the geometrical and mechanical properties [11]. Several studies also have shown that HMB modulates protein turnover [6,7].

The aim of this study was to investigate the effect of HMB maternal administration on body characteristic of newborn offspring.

Material and Methods

The experiment was approved by The Local Ethics Committee on Animal Experimentation of University of Life Sciences in Lublin, Poland.

Pregnant sows

Clinically healthy 8 multiparous sows of Pulawska breed were sired by the same boar and singly housed in the separated cages under standard rearing conditions (controlled temperature, humidity and 12:12-h light-dark cycle) with free access to fresh water and fed twice a day with well balanced standard commercial diet for pregnant and lactating sows (2.3 kg/day/sow).

To investigate detrimental effects of maternal nutrition treatment on the growth of newborn offspring, HMB administration was performed in sows during the period lasting between 70th and 90th days of gestation in pigs (115-116 days). Sows were randomly assigned into two group the control group (n=4; PhS-sows) not administered with HMB and the experimental group (n=6; HMB-treated sows) fed with HMB in the morning (0.2 mg/kg of body weight/ every day; Sigma).

***Corresponding author:** Ewa Tomaszewska, University of Life Sciences in Lublin, Lublin, Poland, Tel: +48 4456973; Fax: +48 4456973; E-mail: ewaRST@interia.pl; ewa.tomaszewska@up.lublin.pl

Received July 06, 2015; **Accepted** July 21, 2015; **Published** July 31, 2015

Citation: Tomaszewska E, Dobrowolski P, Hułas-Stasiak M, Tomczyk A (2015) Maternal Nutrition with B-Hydroxy-B-Methylbutyrate as Strong Determinants of the Development of Newborn Offspring in Pigs. J Neonatal Biol 4: 183. doi:10.4172/2167-0897.1000183

Piglets

The study was performed on 12 male and female piglets born by the control sows as a control group (3 newborns of both sexes from each sow) and 12 male and female piglets born by HMB-treated sows (2 newborns of both sexes from each sow). At the birth, piglets were weight and euthanized by intravenous injection of lethal dose of pentobarbitalum natrium (Morbital, Biowet, Puławy, Poland). Basal vital organs such as liver, heart, lungs, spleen, stomach, kidneys and brain were isolated and weight. Relative organs mass (%) was calculated as a ratio of organ weight and body weight.

The concentration of insulin-like growth factor 1

Changes in the somatotropin axis were assessed by determination of insulin-like growth factor 1. Each newborn pig was not fasted before blood collection. The animal blood was collected using standard venepuncture; next, after clotting at room temperature, it was centrifuged and frozen at -80°C for further analysis. All samples were determined in duplicate. The concentration of the serum porcine insulin-like growth factor 1 (IGF-1) was determined in an IGF-1 kit (ELISA; Uscn Life Science Inc. Wuhan, China). The minimum detection was 7.8 ng/mL.

Statistical Analysis

All the results are expressed as means ± SD (standard deviation). Differences between the means were tested with the One Way ANOVA and post hoc Tukey's test as the correction for multiple comparisons. Normal distribution of data was examined using the W. Shapiro-Wilk test and equality of variance was tested by the Brown-Forsythe test. If there was a lack of normal distribution and/or unequal variance of data, the Kruskal-Wallis ANOVA was used. A P-value of less than 0.05 was considered statistically significant. All statistical analyses were carried out by means of STATISTICA 8.0 software (StatSoft, Inc., Tulsa, OK, USA).

Results

HMB administration did not influence the gestation length, the mean number of stillborn and live born piglets in litters delivered by HMB-treated sows.

Body and organs weight

Maternal HMB treatment significantly increased body mass (57%) and absolute weights all the vital organs except brain in newborn piglets when compared to the control animals (Table 1). The weight of liver, heart, lungs, spleen, stomach and kidneys increases by 160%, 56%, 115%, 67%, 63% and 55%, respectively compared to the control group (Table 1). Although, when relative weight of organ was compared, there was no difference (Table 2).

The concentration of IGF-1

Maternal HMB supplementation significantly enhanced the concentration of IGF 1 in newborn offspring, in which reached the value of 2860 ± 880 pg/mL, while in the control group amounted 910 ± 396 pg/mL.

Discussion

Commonly available food stuffs are generally poor in β-hydroxy-β-methylbutyrate. The highest amount of this substance was found in grapefruit and alfalfa. Other food stuffs like corn consist of HMB in trace amounts of the product [12-14]. Although, the use of substances that have a physiological and nutritional effects, it should only be complementary to the proper diet. In many cases, however, it is impossible to effectively cover the body's increased demand for energy and nutrients exclusively by standard and conventional diet. It requires the use of supplements in practice [15-17].

The weight	Cont	HMB
Body [g]	902.5±91.1	1424.0±126.0*
Liver [g]	17.89±1.89	46.56±6.1*
Heart [g]	6.48±0.60	10.15±1.13*
Lungs [g]	10.69±1.42	22.2±1.85*
Spleen [g]	0.76±0.10	1.27±0.23*
Stomach [g]	5.54±0.64	9.03±0.73*
Kidneys [g]	7.0±1.0	10.88±0.70*
Brain [g]	33.23±1.55	34.82±0.89

Data given are Mean ± SD, * - P < 0.05

Table 1: The body and vital organs weights.

The weight	Cont	HMB
Liver	1.98±2.08	3.27±4.8
Heart	0.72±0.65	0.71±4.84
Lungs	1.18±1.31	1.55±1.41
Spleen	0.08±0.10	0.08±0.18
Stomach	0.61±0.69	0.63±0.57
Kidneys	0.77±1.09	0.76±0.55
Brain	3.76±1.76	2.45±0.70

Data given are Mean ± SD

Table 2: The relative weights (%) of body and vital organs.

In our study, HMB was administered to pregnant sows in the amount of 0.2 g/kg of body weight. This maternal supplementation enhanced body weight of newborns approximately 1.5 fold [11]. In earlier study, where HMB has been given in the amount of 0.05 g/kg of body weight per day, newborns were heavier only about 23% compared to the control group. But, the time of administration differed from this used in presented study. Earlier administration of HMB was performed two weeks before delivery, in the present study HMB was given in the middle gestation through 20 days.

So far conducted studies have shown, that supplementation with HMB is safe even with supply exceeding most often recommended dose and do not affect the appearance of side effects in both humans and animals [18]. Many studies, indicate a significant effect of HMB on the weight and body composition because of anti-catabolic effect, resulting from the stimulation of the synthesis and inhibiting the degradation of muscle protein [19, 20].

In our study, the weight of basal vital organs of newborns offspring was proportional to body size (there was no difference in relative weight) and the concentration one of the markers of somatotropic axis. The supplementation of HMB significantly enhanced the weight of vital organs, although there was no difference in consuming amount of food between groups of pregnant sows. However, additional studies are needed to clarify the mechanisms of the maternal action of HMB on the activity of somatotropic axis.

This study showed that, maternal HMB supplementation in middle gestation significantly improved general growth of offspring influencing somatotropic axis, but the influence of a diet rich in metabolite of leucine should be further investigated. Maternal administration with β-hydroxy-β-methylbutyrate (HMB) during middle gestation has been shown to improve body and basal vital organs mass.

References

1. Gill JW, Hosking BJ, Egan AR (1998) Prenatal programing of mammalian growth - a review of the role of steroids: Liv Prod Sci 54: 251-267.
2. Smith NH, Ozanne SE.(2006) Intrauterine origins of metabolic disease. Rev Gynaecol Perinat Practice 6: 211-217.
3. Holemans K, Aertis L, Van Assche A (1998) Fetal growth and long-term consequences in animal models of growth retardation. Eur J Obstet Gynecol 81: 149-156.
4. Tomaszewska E, Dobrowolski P (2011) Prenatal glucocorticoids can programm postnatal development. J Pre-Clin Clin Res 5: 7-11.
5. Tomaszewska E, Dobrowolski P, Puzio I, Prost L, Kurlak P, et al. (2014) Acrylamide-induced prenatal programming intestine structure in guinea pig. J Physiol Pharmacol 65: 107-115.
6. Nissen S, Sharp R, Ray M, Rathmacher JA, Rice D (1996) Effect of leucine metabolite β-hydroxy-β-methylbutyrate on muscle metabolism during resistance-exercise training. J Appl Physiol 81: 2095-2104.
7. Nissen S, Abumrad NN (1997) Nutritional role of the leucine metabolite β-hydroxy-β-methylbutyrate (HMB). J Nutr Biochem 8: 300-311.
8. Brown SA, Rogers LK, Dunn JK, Gotto Jr AM, PatschW (1990) Development of cholesterol hemostatic memory in the rats is influenced by maternal diets. Metabolism 39: 468-473.
9. Williams J, Abumrad N, Barbul A (2002) Effect of a specialized amino acid mixture on human collagen deposition. Ann Surg 236: 369–375.
10. Tako E, Ferket PR, Uni Z (2004) Effects of in ovo feeding of carbohydrates and β-hydroxy-β-methylbutyrate on the development of chicken intestine. Poult Sci 83: 2023–2028.
11. Tatara RM, Śliwa E, Krupski W (2007) Prenatal programming of skeletal development in the offspring: Effects of maternal treatment with β-hydroxy-β-methylbutyrate (HMB) on femur properties in pigs at slaughter age. Bone 40: 1615-1622.
12. Bassett DR, Howley ET (2000) Limiting factors for maximum oxygen uptake and determinants of endurance performance. Med Sci Sports Exerc 32: 70-84.
13. Baudrand R, Campino C, Carvajal CA, Olivieri O, Guidi G,et al. (2011) Increased urinary glucocorticoid metabolites are associated with metabolic syndrome, hypoadiponectinemia, insulin resistance and β cell dysfunction. Steroids 76: 1575-1581.
14. Baxter JH, Carlos JL, Thurmond J, Rehani RN, Bultman J, et al. (2005) Dietary toxicity of calcium beta-hydroxy-beta-methyl butyrate (CaHMB). Food Chem Toxicol, 43: 1731-1741.
15. Rodriguez NR, Di Marco NM, Langley S (2009) American Dietetic Association; Dietitians of Canada; American College of Sports Medicine: American College of Sports Medicine position stand. Nutrition and athletic performance. Med Sci Sports Exerc 41: 709-731.
16. Calfee R, Fadale P (2006) Popular ergogenic drugs and supplements in young athletes. Pediatrics. 117: e577-e589.
17. Maughan RJ, Shirreffs SM (2012) Nutrition for sports performance: issues and opportunities. Proc Nutr Soc71: 112-119.
18. Holecek M, Muthny T, Kovarik M, Sispera L (2009) Effect of beta-hydroxy-beta-methylbutyrate (HMB) on protein metabolism in whole body and in selected tissues. Food Chem Toxicol 47: 255–259.
19. Wilson JM, Grant SC, Lee SR, Masad I, Park YM (2012) Beta-hydroxy-beta-methylbutyrate blunts negative age-related changes in body composition, functionality and myofiber dimensions in rats. J Int Soc. Sports Nutr 9: 1-11.
20. Zanchi NE, Gerlinger-Romero F, Guimarães-Ferreira L, de Siqueira Filho MA, Felitti V, et al. (2011) HMB supplementation: clinical and athletic performance-related effects and mechanisms of action. Amino Acids 40: 1015-1025.