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Effects of γ-butyrobetaine and l-carnitine on carnitine concentrations in various muscle tissues of finishing pigs

Abstract

The primary method of L-carnitine production, similar to the biological process that occurs in the liver and kidneys, is from microbial fermentation of Î³-Butyrobetaine. Therefore, the objective of this study was to see if supplementing the diet with Î³-Butyrobetaine would increase organ and muscle tissue carnitine concentrations. One-hundred-twenty-five barrows were fed diets containing either L-carnitine (100 ppm), Î³-Butyrobetaine (100 ppm) or a combination of L-carnitine (50 ppm) and Î³-Butyrobetaine (50 ppm). The addition of L-carnitine, Î³-Butyrobetaine and the combination of L-carnitine and Î³-Butyrobetaine increased (P<0.01) free carnitine concentration in the longissimus, diaphragm, and heart. L-carnitine and the combination of L-carnitine and Î³-Butyrobetaine increased (P<0.01) free carnitine concentration in the kidney. Therefore, these results suggest that Î³-Butyrobetaine and/or L-carnitine can be used to increase carnitine concentrations of organ and muscle tissues.; Swine Day, 2007, Kansas State University, Manhattan, KS, 2007

Keywords

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EFFECTS OF γ-BUTYROBETAINE AND L-CARNITINE ON CARNITINE CONCENTRATIONS IN VARIOUS MUSCLE TISSUES OF FINISHING PIGS

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Summary

The primary method of L-carnitine production, similar to the biological process that occurs in the liver and kidneys, is from microbial fermentation of γ-Butyrobetaine. Therefore, the objective of this study was to see if supplementing the diet with γ-Butyrobetaine would increase organ and muscle tissue carnitine concentrations. One-hundred-twenty-five barrows were fed diets containing either L-carnitine (100 ppm), γ-Butyrobetaine (100 ppm) or a combination of L-carnitine (50 ppm) and γ-Butyrobetaine (50 ppm). The addition of L-carnitine, γ-Butyrobetaine and the combination of L-carnitine and γ-Butyrobetaine increased (P<0.01) free carnitine concentration in the longissimus, diaphragm, and heart. L-carnitine and the combination of L-carnitine and γ-Butyrobetaine increased (P<0.01) free carnitine concentration in the kidney. Therefore, these results suggest that γ-Butyrobetaine and/or L-carnitine can be used to increase carnitine concentrations of organ and muscle tissues.

(Key words: vitamins, L-carnitine, γ-Butyrobetaine.)

Introduction

It is well known that Carnitine's role in intermediary metabolism is to transport fatty acyl groups across the mitochondrial membrane. More recent studies have indicated L-carnitine improves sow production, increases body leanness in market hogs, and improves feed efficiency in nursery pigs. The primary method of L-carnitine production, similar to the biological process that occurs in the liver and kidneys, is from microbial fermentation of γ-Butyrobetaine. This process leaves a small amount of residual γ-Butyrobetaine with the L-carnitine. The remaining γ-Butyrobetaine must be removed and discarded. Because γ-Butyrobetaine is a precursor for L-carnitine production in the body, we hypothesized the remaining γ-Butyrobetaine from the production of synthetic L-carnitine may be fed to pigs to increase the L-carnitine levels in muscle tissues. Therefore, the objective of this study was to evaluate the effects of γ-Butyrobetaine and L-carnitine on free carnitine concentration in various muscle tissues.

Procedures

A total of 125 barrows (PIC 1050) with an initial body weight of 165 lb were used. Pigs were blocked by weight and allotted to one of four dietary (Table 1) treatments 34 d before slaughter. Diets were corn-soybean meal-based and were formulated to contain 0.76% total lysine. Vitamin and trace mineral levels were identical to KSU recommendations, and all other nutrients met or exceeded the re-

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quirements estimates provided by NRC (1998). The treatments consisted of a control diet, or the control diet plus 100 ppm of added L-carnitine, 100 ppm of added γ-Butyrobetaine, or control plus 50 ppm of added L-carnitine and 50 ppm of added γ-Butyrobetaine. There were eight pigs per pen and four pens per treatment. Pigs were housed in a modified-open front building with 50% solid concrete and 50% concrete slat flooring. Each 6 × 16-ft pen had a one-hole self-feeder and a nipple waterer to allow *ad libitum* access to feed and water.

Table 1. Basal Diet Composition [a]

Item	%
Corn	83.63
Soybean meal (46.5% CP)	14.00
Monocalcium P (21% P)	0.80
Limestone	0.85
Salt	0.35
Vitamin premix	0.10
Trace mineral premix	0.10
L-lysine HCl	0.15
Corn starch[b]	0.02
Total	100.00

[a] Diets were formulated to 0.76% lysine.
[b] L-carnitine (100 ppm), γ-Butyrobetaine (100 ppm), or L-carnitine (50 ppm) and γ-Butyrobetaine (50 ppm) replaced corn starch in experimental diets.

At the end of the trial, ten pigs per treatment were selected, individually tattooed and slaughtered at the Kansas State University Meats Laboratory. Pigs for slaughter were selected to have similar growth and market weights across blocks. At this time, heart and kidney samples were collected and placed in liquid nitrogen and stored at -80° C until analysis. At 24 hours postmortem, diaphragm and longissimus tissues were collected and placed in liquid nitrogen and stored at -80° C until analysis. Samples were taken from the interior portion of each muscle to ensure uniform samples from the same anatomical region of the tissue. Samples were then packed in dry ice and sent to Metabolic Labs, Madison, WI for analysis of carnitine concentration.

Data were analyzed in a randomized complete-block design using the MIXED procedure of SAS with pig as the experimental unit. Mean separation was used to test for differences between treatments.

Results and Discussion

The addition of L-carnitine, γ-Butyrobetaine, and the combination of L-carnitine and γ-Butyrobetaine to the control diet increased ($P<0.01$) the concentration of free carnitine in the longissimus, diaphragm, and heart (Table 2) of test pigs when compared with control pigs. The addition of L-carnitine and the combination of L-carnitine and γ-Butyrobetaine increased ($P<0.01$) the concentration of free carnitine in the kidney. Although not significant, the addition of γ-Butyrobetaine numerically increased ($P<0.07$) free carnitine in the kidney.

The results of this experiment indicate that L-carnitine and γ-Butyrobetaine may be used to increase free carnitine in muscle tissue. Also, there was no difference in the free carnitine concentration if pigs were fed L-carnitine, γ-Butyrobetaine, or the combination of L-carnitine and γ-Butyrobetaine. Therefore γ-Butyrobetaine could be used with or in place of L-carnitine to increase free carnitine concentrations in muscle. However, the benefits of additional free carnitine concentrations in muscle must be determined in subsequent experiments.

Table 2. Effects of γ-Butyrobetaine and L-carnitine on Free Carnitine Concentration in Organ and Muscle Tissues [a]

	Treatment				
Item (ppm)	Control	L-carnitine [b]	γ-Butyrobetaine [b]	Combination [b]	SED
Longissimus	111.7[c]	162.8[d]	158.7[d]	156.7[d]	6.13
Diaphragm	150.5[c]	200.2[d]	212.2[d]	210.7[d]	7.51
Heart	66.1[c]	101.5[d]	89.2[d]	102.7[d]	5.24
Kidney	12.3[c]	17.0[d]	16.0[cd]	16.3[d]	1.42

[a]Total of 40 pigs, initial weight 165 lb, 10 pigs/treatment.
[b]Diet contained 100 ppm of L-carnitine or γ-Butyrobetaine, or 50 ppm of L-carnitine and γ-Butyrobetaine.
[c, d]Means within rows different superscripts differ ($P<0.05$).