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Growing Forward 2 | Cultivons l'avenir 2

Higher concentrations of the anti-aging carnosine in pork increase its nutritional value and quality

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Introduction

- You may not know but pork contains an important concentration of **carnosine**, a remarkable **health-beneficial molecule** that could change your life or at least extend it!
- Carnosine is an advanced protection system of higher organisms
- Carnosine is a small dipeptide (B-ala-His) naturally produced in large amount in the brain and in the muscle
- Carnosine possesses a wide range of protective biochemical properties that could counteract several mechanisms associated to aging
- No plant-derived molecules offer similar potentialities

Carnosine
Some properties and potential prophylactic and therapeutics applications

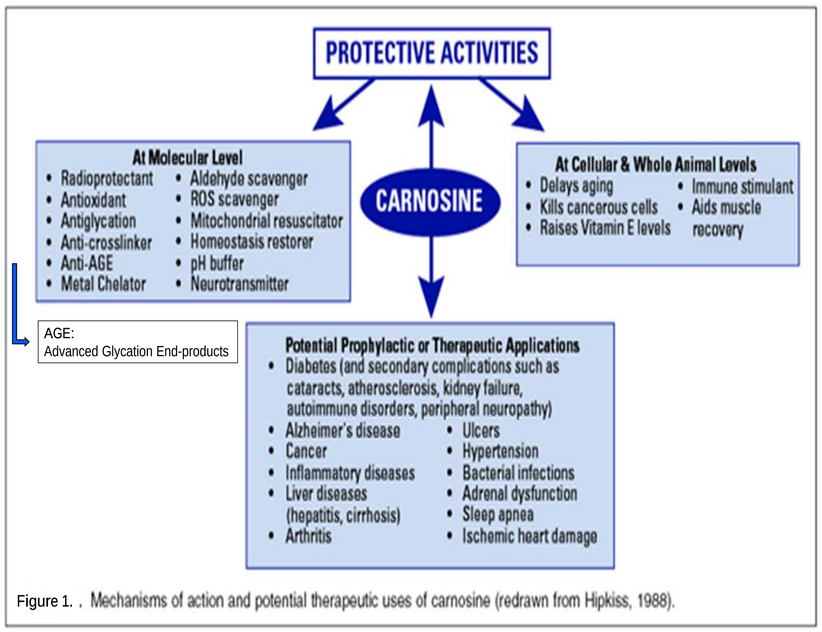


Figure 1. , Mechanisms of action and potential therapeutic uses of carnosine (redrawn from Hipkiss, 1988).

Carnosine also…

- Decreases with age
- Is higher in males than females
- Is higher in omnivores and carnivores than in vegetarians (due to incoming carnosine from muscle food)
- Is higher in white than in red muscles

Carnosine and pigs

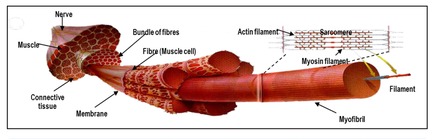
- Pigs are omnivores that are raised on vegetarian diet
- Current level of carnosine in pork are comparable to beef (Table 1)
- Most pork muscles however contain a large proportion of very glycolytic (type IIB) or white muscle fibers exclusive to pork (Table 2)

Table 1. Carnosine and anserine concentrations in common animal species[1]

		Carnosine (mg/100g)	Anserine (mg/100g)
Pig	Loin	313 ★	14,5
	Ham	449	22,9
	Neck	186	10,7
Beef	Loin	375 ★	59,7
	Neck	201	25,4
Lamb	Shoulder	39,3	31,5
	Neck	94,2	119,5
Chicken	Pectoral	180	772
	Leg	63	233
Turkey	Wing	66	775
Salmon		0,53	589

[1]Aristoy & Toldra. Meat Sci. 67: 211-217, 2004

Table 2. Pork muscle fiber composition



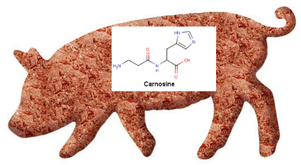
Fibre type	I	IIA	IIX	IIB*
Histochemistry				
Beef	20-30	18-28	48-53	------
Lamb	5-15	41-66	27-46	------
Pork	6-10	10-16	73-85	------
Immuno-histochemistry				
Pork	8,5	4,2	19,3	67,9

Present in small mammals such as mice, rabbits and rats. Pigs are an exception.

Hypotheses

- Current level of carnosine in pork is most likely far from optimal. In supplementing pigs with dietary beta-alanine, the limiting amino acid for carnosine synthesis and understanding its regulation

« Pork could become the best source of carnosine in livestock »



SIP Project Title: Increasing canadian pork consumption, market share and competitiveness through enhanced nutritional values and overall quality with a naturally occuring anti-aging molecule in pork meat (2013-2017)

Objectives:

1- Quantify current levels of muscle carnosine content in Canadian purebred pigs and the relationship between carnosine and pork quality.

2- Evaluate gene expression of genes related to muscle carnosine deposition and investigate genetic variations which could be used to identify pigs with enhanced carnosine levels.

3- Increase pork carnosine content through dietary supplementation with beta-alanine and determine the effect of BA supplementation on gene expression of carnosine-related enzymes and transporters involved in carnosine synthesis and deposition.

4- Determine the effects of enhanced carnosine content on overall sensory, technological and keeping properties of 1- fresh pork, 2- chilled pork, and 3- commonly processed pork products.

5- Compare carnosine content of enhanced pork with current levels in Canadian pork, beef and poultry and also commercial US pork.

6- Determine consumer reactions to advantages of carnosine-enhanced pork, how to provide the messages to consumers and the potential uptake of enhanced pork.

7- Develop domestic and export marketing strategies and non-nutrient declaration for carnosine-enhanced pork.

Protocols

1. Evaluation of pork samples from major Canadian breeds
- Duroc, Landrace and Yorkshire barrows from 16 breeding herds across Canada were raised at the Deschambault test station (Quebec, Canada)
- Slaughtered upon reaching 120kg (liveweight)
- Meat quality measurements at 24h post-mortem (pH, meat color, water holding capacity, tenderness)
- Carnosine and anserine quantification by HPLC

2. Nutritional trial
- 80 commercial pigs (65 Kg); fed 0, 720, 1440 and 2160 mg BA /kg diet / 8 weeks
  0, 30, 60 and 90 mg BA / Kg BW / day / 8 weeks
- Growth performance, Meat quality and Gene expression measurements

Results overview

- Large differences found in muscle carnosine between breeds and also animals (from 205 to 382 mg/100 g tissue) show potential for genetic improvement.
- Duroc contains higher carnosine content than Yorkshire and Landrace (Fig. 2)
- Higher carnosine content is associated with improved meat colour and water-holding capacity (Table 3)
- Pig genetic background is a key determinant for muscle carnosine content (results presented in D'Astous-Pagé, J., Gariépy, C., Blouin, R., Cliche, S., Sullivan, B., Fortin, F., Palin, M.-F. 2017. Carnosine content in the porcine longissimus thoracis muscle and its association with meat quality attributes and carnosine-related gene expression Meat Science, Volume 124, 2017, 84–94)
- At the level used, dietary supplementation with beta-alanine did not increased muscle carnosine but decreased lipid and protein oxidation
- Further work is underway and the project will be completed at the end of 2017

Results (continued)

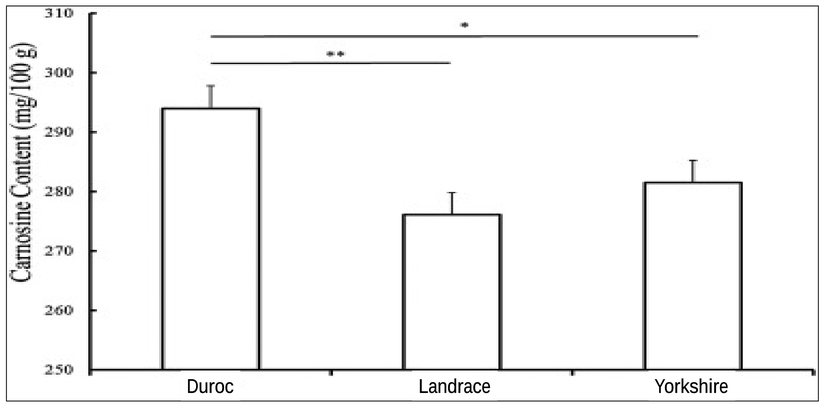


Fig. 2. Carnosine content in the longissimus thoracis muscle of Duroc (n = 85), Landrace (n = 92) and Yorkshire (n = 105) pigs. * P ≤ 0.05; ** P ≤ 0.01

From:
D'Astous-Pagé, J., Gariépy, C., Blouin, R., Cliche, S., Sullivan, B., Fortin, F., Palin, M.-F. Carnosine content in the porcine longissimus thoracis muscle and its association with meat quality attributes and carnosine-related gene expression. Meat Science, Volume 124, 2017, 84–94

Table 3. Meat quality parameters in the Longissimus thoracis muscle of Low, Medium and High groups of muscle carnosine content within Duroc, Landrace and Yorkshire pigs.

	Duroc					Landrace					Yorkshire				
	Low	Medium	High	SEM	P-value	Low	Medium	High	SEM	P-value	Low	Medium	High	SEM	P-value
	n = 23	n = 44	n = 18			n = 30	n = 39	n = 23			n = 40	n = 47	n = 18		
Carnosine content (mg/100g)	246.84^{c}	294.34^{b}	353.47^{a}	4.49	<0.001	242.91^{c}	274.21^{b}	322.47^{a}	4.57	<0.001	254.05^{c}	284.83^{b}	333.64^{a}	4.11	<0.001
Color a*[1]	4.46	4.47	4.16	0.21	0.48	4.39	4.12	4.59	0.21	0.27	4.80^{a}	4.89^{a}	5.35^{a}	0.19	0.08
Color b*	7.06^{a}	6.73^{a}	5.80^{b}	0.30	0.01	7.30^{a}	6.90^{a}	6.69^{a}	0.26	0.09	7.03	6.97	7.14	0.20	0.80
Color L*	53.51^{a}	52.27^{a}	48.41^{b}	0.87	<0.001	54.42^{a}	53.29^{a}	52.60^{a}	0.71	0.05	52.98	52.33	52.07	0.61	0.31
Cooking loss (%)	17.96^{ab}	18.76^{a}	15.90^{b}	0.82	0.01	18.87	19.15	18.51	0.33	0.36	18.83	18.94	18.10	0.36	0.15
Shear force (N)	21.80^{b}	25.22^{ab}	27.65^{a}	1.67	0.02	27.02^{a}	26.95^{a}	30.76^{a}	1.41	0.06	27.01^{a}	29.20^{a}	27.57^{a}	1.09	0.06
Drip loss (%)	3.71^{a}	3.23^{a}	2.01^{a}	0.58	0.08	3.74	3.91	3.96	0.59	0.92	4.53^{a}	3.59^{ab}	2.97^{b}	0.39	0.01
pH 24h	5.63^{b}	5.64^{b}	5.86^{a}	0.07	0.01	5.55^{b}	5.57^{ab}	5.63^{a}	0.03	0.03	5.57^{b}	5.59^{ab}	5.66^{a}	0.03	0.04

[1] Color a*, b* and L* are estimated with a Minolta Chroma Meter CR-300 colorimeter

Conclusions and implications

- Large differences in carnosine levels between breeds and also animals show potential for genetic selection, while more work is needed on nutritional supplementation to enhance carnosine in pork
- Higher levels of carnosine were associated with several pork quality attributes
- Macromolecular glycation and associated pathologies could be ameliorated by diets containing carnosine (BrownLee M. 2001. Nature 414:813-820)
- Such a unique and relatively unknown health advantage (e.g. increased carnosine content) could differentiate Canadian pork from other food commodities potentially helping the pork industry reach increased market share and change the entire health-related paradigm with meat consumption

Acknowledgements

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Swine Innovation Porc | Canada Pork International / Canada Porc International | Canadian Centre for Swine Improvement / CCSI | CCAP / Centre canadien pour l'amélioration des porcs | Canadian Pork Council / Conseil canadien du porc | Jefo Life, made easier | CDPQ Centre de développement du porc du Québec inc. | Canada