



Adequate muscle creatine – why is it important for broilers?

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Birds are omnivorous species, they are evolutionarily designed to consume products from plant and animal origin. However, for several reasons, poultry nutrition is shifting more and more to a vegetable diet. This shift has resulted in losing some important benefits of animal products, including creatine, an essential compound found in meat but not in plants.

Does creatine in processed animal proteins reflect natural levels?

A feed ingredient survey conducted at AlzChem showed that creatine values found for meat meal (n=38) or fish meal (n=25) are low (median at 0.2 and 1.1 g/kg respectively) and drastically below the values expected from fresh origins when calculated on dry matter (16.7 g/kg from fish, 21.7 g/kg from meat). So, creatine is lost on the way from the original natural substance to the feed ingredient. (Table 1)

Creatine source	Fish	Meat
Meal (median)	1.1	0.2
Muscle (fresh)*	6.5	5.0
Muscle (dry)**	21.7	16.7

*Sports Med. (1994), 18(4), 268-280 **on 30% DM

Table 1 : Creatine contents in fresh fish or meat on DM compared to fish meal or meat meal in g/kg

Why is creatine important?

Creatine is an essential molecule for cellular energy supply. Its active form phosphocreatine is the immediate backup reservoir in the body to replenish ATP, the central energy source in the cell. As without ATP any cell will die, the body stores

creatine for times when ATP need is higher than production via mitochondria or metabolism of carbohydrates or lipids. If creatine is not provided from food, body creatine levels are compromised and must be supplied entirely by de novo endogenous synthesis from amino acids.

The body can run short in ATP on many occasions.

To name a few:

- 1 Rapid growth, where important amounts of ATP are absorbed for protein synthesis
- 2 Excitement or stress, not only for escape but also for macrophages to fight pathogens
- 3 Low oxygen supply leading to low ATP production
- 4 Disturbed energy metabolism, i.e. impaired mitochondrial function

All of these conditions are also found in poultry animal husbandry and might have increased over the past years. Broiler growth has improved dramatically since the last 50+ years (roughly a factor of four since 1957). Growth was directed specifically to increased carcass (+12%) and breast meat yield (+50%). White muscle (such as chicken breast) consists almost solely of muscle fibers high in creatine (fast twitch type IIb fibers). Knowing that creatine not only supports myogenesis but also stabilizes cell membranes, can we speculate that the substantial carcass and breast muscle growth was supported by elevating muscle creatine?

In fact, in 1956, just ~3gr creatine per kg muscle are reported in 21d broilers fed practical diets, but ~4 gr/kg muscle are found in 2018 for broilers of the same age (+33%). It seems evident that more creatine is stored in the muscle to support growth. Are these levels adequate?



Creamino® improves muscle creatine to support protein accretion. Energy for healthy growth!

Options to provide creatine to broilers

Dietary supplementation with creatine has proven to increase muscle creatine by roughly 20% in humans. Effects are most pronounced when natural creatine from food is low. Creamino®, a preparation containing the creatine precursor guanidinoacetic acid (GAA, 96 % min), is established as a highly efficient source of creatine for broilers. A dose range of 600-1200 mg/kg feed was derived from growth experiments whilst ~600 mg/kg are suggested from a factorial calculation. Interestingly, 1086 mg creatine/kg feed would be obtained from 5% inclusion of fish meal containing creatine as present in dry fish (21.7 g/kg), so falling in the same range as derived for Creamino®. (Figure 1)

Comparison to fish meal: Creamino® Improves muscle creatine, growth and breast yield

Creamino® has been shown in numerous experiments to elevate muscle creatine in broilers. In a comparison study (d0-39) with ROSS 308 broilers, fishmeal (PC) added at 6%, 3% and 3% in starter, grower and finisher diet respectively showed very low impact on muscle creatine (+3%) as compared to the pure plant based control (NC, corn/soy). This was expected from the poor creatine content in the fishmeal (1.7 g/kg). In contrast, Creamino® added at 0.06% or 0.12% improved muscle creatine content (+11% and +16% respectively), (Figure 2, top). Performance effects were most striking in the grower phase ($p < 0.5$) and overall ($p < 0.1$), where 0.12 % GAA improved FCR by 4 points, whilst PC and NC were not different. Contrast analysis showed that Creamino® groups improved final body weight compared to the pure plant based diet as did the fish meal diet. Creamino® groups had higher breast meat yield but similar leg yield, whilst fish meal had no effect on breast meat yield and even reduced lower leg yield. Carcass yield and breast meat yield were clearly highest from the 0.12% Creamino® treatment (+0.6% and +0.5% compared to NC and PC for carcass yield, +1.3% and +0.5% compared to NC and PC for breast meat yield), altogether proving the relevance of muscle creatine for growth and protein formation. (Figure 2, bottom)

Poult. Sci. (2012), 91, 402-412

Creatine equivalent by feed type (mg/kg)

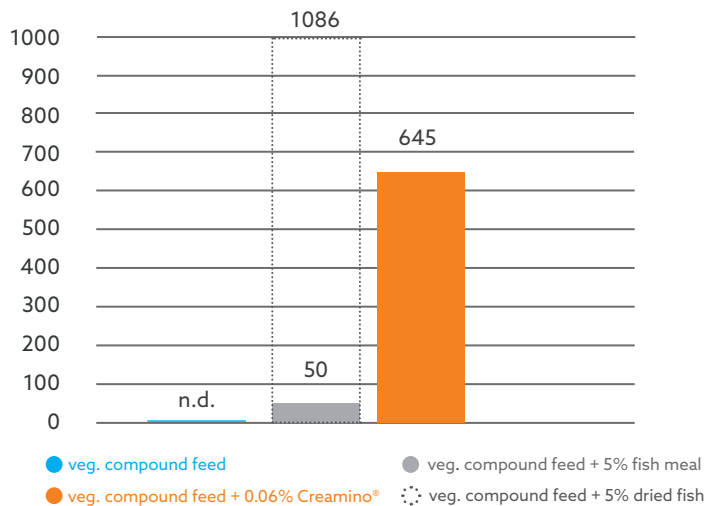
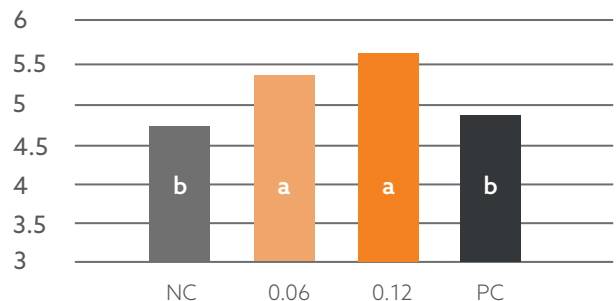


Fig 1: Creatine levels from grains, 5% fish meal, 5% dry fish, 0.06% Creamino®

Creatine mg/kg



Breast meat, %

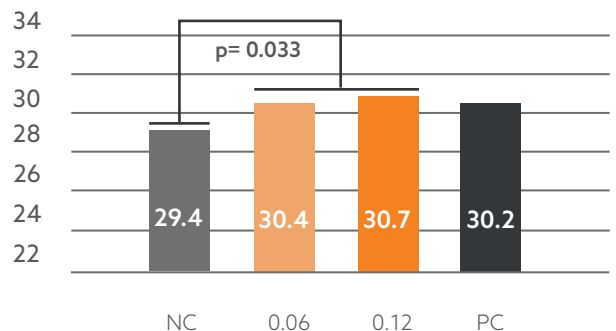


Fig 2: Muscle creatine (top) and breast meat yield (on carcass) (bottom) from either vegetarian diet (NC), Creamino® or inclusion of fish meal (PC) fed to ROSS 308 male broilers for 39 days



Improved muscle creatine counteracts Arginine imbalance and supports lean meat

Physiological creatine levels in the body modulate the endogenous syntheses of GAA from arginine and glycine via the AGAT enzyme. When serum creatine levels are high because of saturated muscle creatine, AGAT is downregulated and arginine and glycine are released for other purposes. In diets low in arginine, this effect is highly relevant.

This is evidenced by a feeding experiment for only two weeks (d13-27) with broilers fed an Arg-deficient basal diet or the basal diet with stepwise additions of L-Arg up to the requirement and with or without Creamino®. Supplementing Creamino® increased muscle creatine and bird performance at all levels of dietary Arg. Looking at the extremes (0.90% and 1.25% total Arg), Creamino® showed highest response in muscle creatine at the lowest Arg-level (+32% at lowest Arg and +18% at adequate Arg). 0.06% Creamino® or 0.35% L-Arg added to the 0.90% Arg diet achieved the same muscle creatine level. (Figure 3 top)

Interestingly, independent of arginine, a trend towards elevation of breast muscle protein was observed ($p=0.1$ for Creamino and L-Arg), in line with the well established effect for creatine in human application. (Figure 3, bottom) *Poult. Sci. (2019), 98(E-Suppl.1),158, Eur. Symp. Poult. Nutr. (2013), 19*

Conclusion

There is clearly a deficiency of creatine in today's broilers. Even when fed diets containing animal proteins, muscle creatine stores are not adequately filled. Creamino® is an effective source of creatine as confirmed by improved muscle creatine and protein accretion.

Energy for healthy growth!

AlzChem, founded in 1908 in Bavaria, Germany, has a history as a chemical and agricultural company for over 100 years. Coal and lime form the basis of AlzChem's product range, which covers nitrogen fertilizers and a wide range of subsequent products, amongst them biological active guanidinium compounds, like creatine and guanidinoacetic acid. AlzChem is the only western creatine producer left because of its superior position (integrated and patent protected production in a dedicated GMP-plant, know-how on creatine application, global scientific network). AlzChem has established in house analytical methods for creatine and GAA analysis in food, feed and biological matrix. AlzChem stands for ultrapure creatine since 1995 and Creamino® since 2005.

Fully backwards integrated production and raw material control, entirely made in Germany, strong analytical competence and scientific network. **All in one hand.**

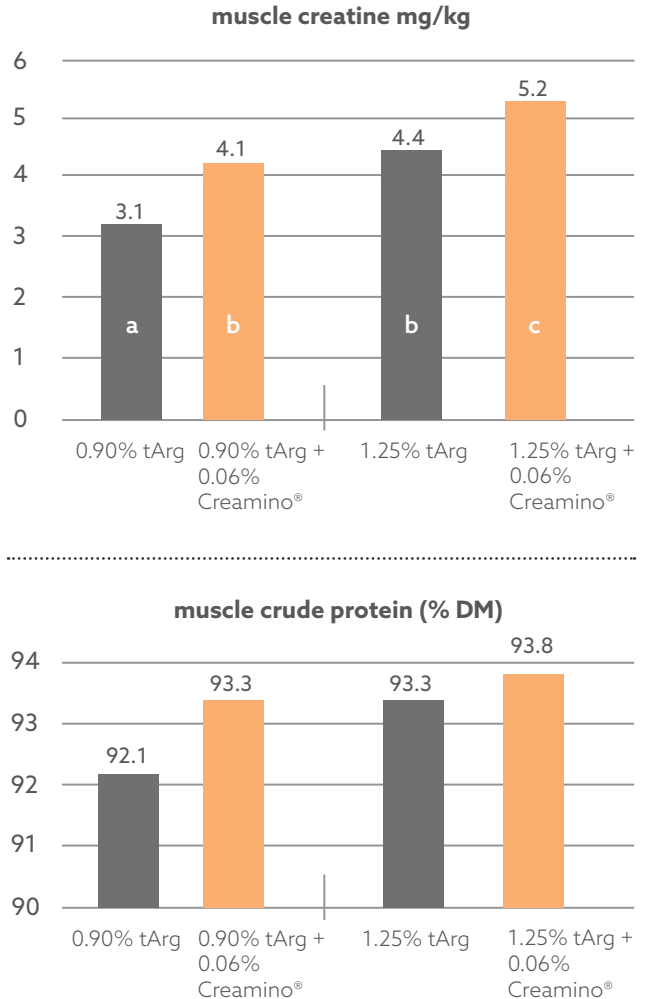


Fig 3: Muscle creatine (top) and crude protein in breast muscle (bottom) in male ROSS 308 broilers fed 0.06% Creamino® added to low Arg (0.90% total Arg) or adequate Arg (1.25% total Arg) for 14 days (d13-27).

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