AMINONews®

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AMINOChick® 3.0 – updated amino acid recommendation tool for broilers with additional features

Key information

- AMINOChick® 3.0 is an online tool providing recommendations for standardized ileal digestible (SID) essential amino acids, which can be adjusted to various production conditions. As new addition to previous recommendations,
    - AMINOChick® 3.0 provides recommendations for SID glycine equivalents (SID Gly + 0.714 x SID Ser)
    - AMINOChick® 3.0 suggests creatine requirement and recommends respective supplementation of guanidinoacetic acid
- AMINOChick® 3.0 allows to adjust amino acid recommendations to phase feeding programs, sex of birds, dietary energy level, physical feed quality. As new addition to previous recommendations,
    - AMINOChick® 3.0 allows to adjust amino acid recommendations to various production objectives.
    - AMINOChick® allows adjustment of amino acid recommendations to target body weight.
    - AMINOChick® 3.0 provides amino acid recommendations for concentrates in case of blending with whole grains.
- AMINOChick® 3.0 includes a feature which helps the user to adjust specifications of sulfur containing amino acids according to the perception of the nutritional value of methionine sources.
- Scenarios calculated with AMINOChick® 3.0 can be saved and compared with others.

1. AMINOChick® 3.0 – Revision and new features

Requirement and recommendation don't have the same meaning

Amino acid (AA) requirements and AA recommendations do not mean the same. Requirements would be expressed quantitatively in g/bird/day or g/kg $BW^{0.67}$/d and refer mainly to the animal. Requirements would be dedicated to a certain purpose such as growth, meat deposition, maintenance, immune response, etc. or a combination of those. In contrast, recommendations shall give an indication on the optimal concentration of AA in the feed (% of diet, g/kg feed) which shall ensure sufficient intake of the required nutrients. This already implies that recommendations not only have to consider feed intake but also requirements for various purposes.

Following the factorial approach, AA requirements of broilers for growth or meat deposition and maintenance are summed up and certain conversion factors (efficiencies) for digestible AA would describe the utilization of AA usually under optimal conditions. Apparently, this approach allows modelling as various factors can be included and conversion factors can be modified. Data from dose-response feeding trials, in contrast, reflect broiler responses to the specific circumstances under which the trial has been conducted. This explains why dose-response trials with the same experimental design rarely have exactly the same outcome. Genetic progress has huge impact as the proportion between maintenance and performance requirement changes. Cerrate and Corzo (2019) reported that body protein content of broilers increased continuously and almost linearly from about 16.5% to 19.9% during the period from 2001 to 2017 whereas body fat content decreased from about 16.0% to 9.0%. These data had been normalized to 2268 g body weight suggesting that bird's requirements were affected by genetic progress and, indeed, the estimated digestible Lys intake for weight gain increased mainly because of increased (breast) meat deposition whereas that for maintenance rather decreased. However, overall digestible Lys intake was relatively constant and even tended to decrease over time whereas utilization of digestible Lys for deposition tremendously improved. The latter goes along with a continuous improvement of feed conversion ratio (Cerrate and Corzo 2019) which demonstrates the impact of feed intake. Lysine requirement can also be affected by sex, age and the targeted production objective as reviewed by Alhotan and Pesti (2016). Interestingly, these authors proposed that the optimal ratio between digestible Lys and true protein (from anhydrous amino acids) is rather stable and does not change with age. An influence factor which increasingly comes into the focus is the requirement for health and immune responses. It is meanwhile common sense that health, management and performance have to be considered for nutrition and should be optimized simultaneously. While prevention of diseases by prophylactic means (biosecurity, hygiene, antibiotic alternatives) would avoid extra AA requirements for immune responses and would, thus, make determination of requirements easier, an immune response may require significant amounts of AA which would not be available for performance anymore. Already in 1999, (Klasing and Calvert) estimated the Lys cost for adaptive and acute immune responses which may amount up to 6.5% of the entire Lys intake of young chicks. They further concluded that "up to 60% of the impaired growth that occurs during an intense immune response can be accounted for" by adaptive and acute immune responses.

AMINOChick® 3.0 uses the factorial approach

Lysine is a key AA because it is used as reference AA for the ideal protein concept. In comparison to other amino acids, Lys is almost exclusively retained in body protein while requirement for maintenance is rather low. There are also only little interactions with other AA in contrast to the sulfur amino acids which are usually first limiting. Methionine can be transformed irreversibly into cysteine with high efficiency (Lewis 2003; D'Mello 2003). However, there are antagonistic effects between Lys and Arg which are mainly explained by a competition for renal tubular reabsorption and also by enhanced Arg degradation due to stimulation of the renal arginase activity at high Lys supply (Khajali and Wideman 2010). The factorial approach applied in AMINOChick 3.0 considers protein deposition and maintenance requirement and the respective Lys needs.

In AMINOChick® 3.0 recommended standardized ileal digestible (SID) Lys as well as the entire AA profile can be adjusted to various production factors:

- **Age and feeding phase length**
  According to changing daily weight gain and daily feed intake optimal SID Lys levels are calculated according to a factorial approach and related to the phases and duration of phases which are defined by the user. A maximum of 6 phases with a maximum age of 70 days represent the frame.

- **Physical feed quality**
  The physical feed quality affects feed intake of the birds as with increasing proportion of fines, intake decreases. In order to ensure that with decreasing feed intake still the required quantities of SID AA are consumed by the broilers, SID AA concentrations are uplifted in case of low physical feed quality. The user can choose from three qualities (poor, medium, good)

- **Dietary energy**
  Basically it is assumed that birds can maintain their energy intake by adjusting their feed intake – at least within a certain range. Therefore, AMINOChick® 3.0 adjusts the SID AA concentration at changing metabolizable energy accordingly in order to also maintain AA intake.

- **Feeding strategy (compound feed or concentrate for whole grain blending)**
  In some parts of the world it is common practice to blend concentrates with (home grown) whole grain. The intention is usually to save money. However, in order to avoid a dilution of SID AA with this procedure, AMINOChick® 3.0 adjusts the AA concentrations and AA profiles of the concentrate according to the dietary proportion and AA profile of the grain (Figure 1). The user can choose from grain qualities obtained from AMINODat 6.0 or enter own analytical data.

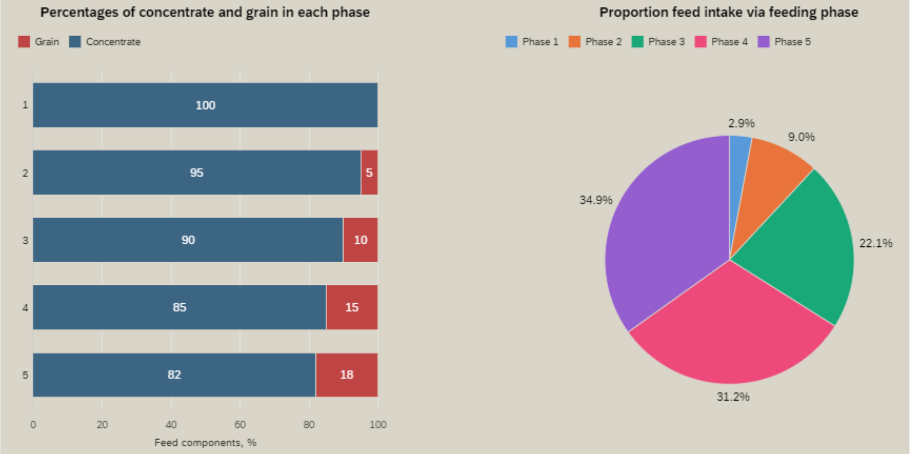

Figure 1: Example for a feeding program with increasing proportions of whole grain blended with a feed concentrates in a 5-phase feeding schedule.

- **Sex of birds**
  Male and female birds have different growth characteristics and feed intake curves. AMINOChick® 3.0 therefore adjusts SID AA recommendations to male, female or mixed sex (50:50) broilers.

- **Performance objective and targeted final body weight**
  Globally speaking, broiler growers have different production objectives in mind depending on the payment system. Therefore, they may target minimization of feed conversion ratio, maximizing body weight gain or maximizing breast meat yield. Different performance objectives would require different SID AA concentrations in feed. Moreover, AMINOChick® 3.0 makes the attempt to adjust the SID AA levels to a defined final, targeted body weight (Figure 2).

Figure 2: Example for adjusting the standard growth curves expecting 4600 g body weight at day 63 to a target weight of 4000 g body weight in mixed sex broilers.

As explained above, AMINOChick® 3.0 calculates optimal dietary SID Lys level by a factorial approach. Once the SID Lys levels are defined, an ideal AA profile is applied to calculate the concentrations of the other essential AA. As shown in Table 1 this AA profile varies with age for most of the amino acids which is considered in AMINOChick® 3.0.

Table 1: AMINOChick® 3.0 amino acid profile in comparison to other recently published profiles.

	AMINOChick® 3.0		Liebert (2017)	Wecke and Liebert (2013)		Wu (2014)		Federatie Nederlandse Diervoederketen (2018)		(Rostagno *et al.*2017)
	starter	finisher	Lit.-review[a]	starter[b]	grower[b]	starter	finisher	Max. growth[c]	Min. FCR[c]	starter/ finisher
	SID[d]	SID	n.d.	total	total	TD	TD	SID	SID	SID
Ratios to SID Lys (Lys = 100)										
Met+Cys	72	77	74			72	75	73	74	74
Thr	63	66	66	60	62	67	70	64	62	66
Trp	16	17	16	19	17	16	17	15	13	18
Arg	103	106	105	105	105	105	108	107	112	107
Val	79	81	80	63	79	77	80	77	73	77
Leu	107	107	110			109	109	110	110	107/108
Ile	68	71	69	55	65	67	69	60	63	67/68
His	33	33	34			35	35			37
Phe+Tyr	116	116	120			105	105			115
$Gly_{equivalents}$[e]	121	113				224	224	105/115[f]	103/111[f]	124/113[g]

[a] including 26 references [b] based on N-utilization model approach [c] for maximum growth; for minimum feed conversion ratio throughout all feeding phases [d] SID: standardized ileal digestible; TD: true digestible [e] $Gly_{equivalents}$ = Gly + 0.714 * Ser [f] Federatie Nederlandse Diervoederketen (2018) recommends SID Gly+Ser for 1st (125%; 122%) and 2nd (136%; 132%) week of age only. Values were recalculated to $Gly_{equivalents}$ assuming 45% dig. Gly and 55% dig. Ser [g] Rostagno et al. (2017) reported digestible Gly+Ser (147% starter; 134% finisher), therefore, values were recalculated to $Gly_{equivalents}$ assuming 45% dig. Gly and 55% dig. Ser

The AA profile (Lys = 100%) used by AMINOChick® 3.0 as well as other recently published AA profiles for broilers are presented in Table 1. Most of the profiles refer to digestible (SID, TD) amino acids. The literature review by Liebert (2017) included various methodological approaches. Profiles by Wecke and Liebert (2013) refer to total AA. Basically, there is an acceptable consistency between references. There is a particularly good agreement between Liebert (2017) and AMINOChick® 3.0 which should not be surprising as similar references were considered. Wecke and Liebert (2013) on the one hand based their AA profile on total amino acids and on the other hand also used a specific methodology for determination (exponential N-utilization model). This might explain why the reported ideal Met+Cys, Val and Ile to Lys ratios turned out rather low compared to AMINOChick® 3.0. Wu (2014) based his AA profile on body and tissue AA analyses utilized in a factorial approach. The only remarkable difference of the Wu (2014) AA profile is TD $Gly_{equivalent}$: TD Lys ratio. While available information on $Gly_{equivalent}$ requirement is still little and outcomes are variable, both Gly-research (Siegert *et al.*2015a; Siegert *et al.*2015b; Akinde 2014) as well as low protein research (Lemme and Rodrigues 2020) would suggest $Gly_{equivalent}$: Lys not as high as Wu (2014). While AA profiles recommended by Federatie Nederlandse Diervoederketen (2018) do not distinguish between age periods (except for $Gly_{equivalents}$), they differentiate between production objectives. The recommendations are based on a literature review and compared to AMINOChick® 3.0 and Liebert (2017) most ratios by Federatie Nederlandse Diervoederketen (2018) are on the lower edge. To a large extent this is explained by the method of data analysis. For each AA, the authors analyzed the data of the original dose-response studies not on the basis of digestible AA but related the responses to recalculated SID AA : SID Lys ratios. However, original publications did not provide any indication whether Lys was second performance limiting AA in their assays which – if this is not the case – bears a large risk of underestimation of the ideal AA ratios. Therefore, the numbers by Federatie Nederlandse Diervoederketen (2018) have to be read with caution.

Table 1 does not explicitly report the SID Met : SID Met+Cys ratio but recommended ratio is ≥55%. Pacheco et al. (2018) recently determined the optimal Met to Met+Cys ratio of 52% in a dose-response trial supported by additional trials using stable isotopes. Research by Kalinowski et al. (2003) suggested optimal dig. Met : dig. Met+Cys ratios between 52 and 55% confirming earlier findings as stated in their paper.

AMINOChick® 3.0 provides recommendations for glycine equivalents

In addition to previous AMINOChick® recommendations, AMINOChick® 3.0 provides recommendations for SID $Gly_{equivalents}$ as $Gly_{equivalents}$ can be performance limiting especially when dietary protein shall be minimized (Lemme and Rodrigues 2020). Research recently focused on Gly and its role in nutrition suggesting a complex Gly metabolism (Siegert *et al.*2015b;

Siegert *et al.*2015a; Akinde 2014). First, Gly can be a precursor of Ser in a reversible biochemical pathway (Siegert *et al.*2015a). Therefore, both AA are expressed as Gly equivalents ($Gly_{equivalents}$ = Gly + 0.714 x Ser). Moreover, also Thr can be a precursor of Gly - a relationship between $Gly_{equivalents}$ and Thr which has been reviewed by Siegert et al. (2015a). Therefore, e.g. Belloir et al. (2017), Lemme et al. (2019), Hilliar et al. (2019a), and Chrystal et al. (2020) increased Thr levels in their diets to counterbalance low dietary Gly in their low CP research. While they found negative correlations between $Gly_{equivalents}$ and Thr intake, it was not possible to quantify this effect. The main pathway for Thr conversion into Gly is using Thr-dehydrogenase (Malinovsky 2018) but research by Yuan and Austic (2001), Lee et al. (2016) and Hilliar et al. (2019b) suggested that Thr-dehydrogenase activity was considerably reduced when dietary protein was reduced. Indeed, recent research suggested that this precursor effect of Thr is – if at all – rather ineffective at least at dietary protein reduction (Hilliar *et al.*2019b; Chrystal *et al.*2020). In addition, supply of choline (betaine) can also interact with Gly metabolism because degradation of a choline or betaine molecule would release a molecule of Gly (Siegert *et al.*2015a). There is also a relationship to Met and Cys as transformation of Met to Cys requires one molecule of Ser (Siegert *et al.*2015b). Most of the commercial, vegetarian broiler diets are usually deficient in Cys which easily can be accounted for by Met supplementation. However, this consequently would increase the metabolic $Gly_{equivalent}$ demand. Also, formation of glutathione which is an important antioxidant coping with reactive oxygen species in the body needs Gly for its synthesis. Insofar, Gly plays indirectly a role in oxidative stress defense and Gly demand depends on occurrence of reactive oxygen species. Finally, Gly is involved in N-excretion (D'Mello 2003). For each molecule of uric acid which is formed to excrete nitrogen, one nitrogen atom from Gly is incorporated which means, the lower the dietary N-excretion the lower is the metabolic Gly requirement. This is, by the way, in contrast to mammals excreting nitrogen as urea without the specific involvement of Gly. Therefore, improving N-utilisation by balancing dietary AA according to the ideal protein per se but especially in low CP diets will have major impact on the Gly requirement in poultry. For example, Lemme and Rodrigues (2020) concluded from their literature survey that successful low protein diets fed to broilers 22 to 37 days of age contained a SID $Gly_{equivalent}$: SID Lys ratio of at least 112%. Having said this, it might also be noticed that dietary protein reduction mainly means a reduction of so-called non-essential amino acids including Gly and Ser. Recommended $Gly_{equivalents}$ by AMINOChick 3.0 are related to a certain extent to the low protein research (Lemme and Rodrigues 2020) implying that high, unbalanced dietary protein supply would increase $Gly_{equivalent}$ requirement. Gly metabolism can be modelled and flows between metabolic pools of Gly, Ser, Thr, Met, Cys, choline, betaine, creatine, glutathione, N-excretion and others can be estimated (Wang *et al.*2013). While this is based on a few assumptions e.g. on quantification of daily glutathione and creatine formation or N-excretion, it clearly indicates a large gap between dietary $Gly_{equivalents}$ supply and the metabolic demand suggesting a high de-novo synthesis rate of Gly. Indeed, Gly is categorized as conditionally essential AA which suggests that under certain physiological and nutritional conditions de-novo formation of Gly is not sufficient for optimal performance. Insofar, $Gly_{equivalent}$ recommendations AMINOChick 3.0 assume rather balanced conditions. An example for $Gly_{equivalent}$ recommendations can be obtained from Table 2.

Table 2: AMINOChick® 3.0 recommendations for a scenario with mixed sex broilers in a 5-phase feeding program

Sex:		As hatched				**Physical feed quality:**			Good		
Performance Objective:		Min. feed conversion ratio				**Feed Type:**			Compound Feed		
Feeding phase		**Age range (days)**		**AMEn (MJ/kg)**							
1		1 – 10		12.7							
2		11 – 21		12.9							
3		22 – 35		13.0							
4		36 – 49		13.1							
5		>50		13.2							
Recommended SID AA (% of diet)											
	Lys	**Met**	**Met+Cys**	**Thr**	**Trp**	**Arg**	**Val**	**Ile**	**Leu**	**His**	**Phe+Tyr**	**Gly_{equi}**
1	1.31	0.52	0.94	0.83	0.21	1.34	1.03	0.89	1.40	0.43	1.52	1.58
2	1.18	0.48	0.87	0.76	0.19	1.22	0.94	0.82	1.26	0.39	1.37	1.40
3	1.02	0.42	0.77	0.66	0.17	1.07	0.81	0.72	1.09	0.34	1.18	1.17
4	0.92	0.39	0.71	0.61	0.15	0.98	0.74	0.66	0.99	0.30	1.07	1.03
5	0.87	0.38	0.69	0.58	0.15	0.94	0.71	0.64	0.93	0.29	1.01	0.94

Functional properties of amino acids may affect optimal dietary level and ratio to lysine

The AA profile suggested by AMINOChick® 3.0 is applicable and validated by a feeding trial (see Lemme 2021). However, it should be noted that ratios of some amino acids might be enhanced rather than reduced in order to optimize AA supply under certain production conditions and to consider functionality of AA:

- **Methionine + Cysteine**

  In addition to being building blocks for body and feather protein synthesis, **Met and Cys** have additional functionalities (Lewis 2003; D'Mello 2003). Accordingly, they are involved in oxidative stress defense, methyl group donation, and polyamine synthesis. In context of oxidative stress, particularly Cys plays a role as it is needed for glutathione formation. In most of the common broiler diets, especially plant-based feeds, Cys is deficient but the nutritional gap can easily be solved by additional MetAMINO® because Cys can efficiently be formed out of Met via the transsulfuration pathway. In case of oxidative stress, glutathione synthesis is stimulated and Cys as well as Gly and Glu are required for synthesis and are, therefore, less available for meat deposition. Under commercial conditions, oxidative stress situations can easily occur e.g. due to heat stress, antinutritional factors, etc.. Evonik's AMINOLab® and AMINOInsight data indicate that dietary Met+Cys levels often are well below the optimal SID Met+Cys : SID Lys ratio which increases the risk of suboptimal supply under stress conditions (Evonik 2016). Moreover, in addition to a wrong perception of the bio-availability of Met-hydroxy analogue compared to DL-Met, nutritionists sometimes believe they could replace supplemental methionine by betaine or so-called herbal Met. In this context a bio-availability of Met-hydroxy analogue of 65% relative to DL- and L-Met has been recommended and validated (Lemme *et al.*2012) while there is no difference between DL-Met and L-Met with respect to nutritional value (Ali 2018). In addition, several feeding experiments consistently demonstrated that betaine (as well as choline) has no potential to replace dietary Met (Schutte *et al.*1997; Mueller *et al.*2017; McDevit *et al.*2000). Same applies to so-called herbal Met products (Sangali *et al.*2014; Madsen and Semakanit 2009). Betaine and – indirectly – choline indeed plays a role for remethylating homocysteine to methionine but cannot replace methionine. Methionine in turn donates methyl groups to for DNA activation and to a large extent to creatine synthesis. Creatine has an important function in cell energy metabolism and is located to >90% in muscle tissue (Khajali *et al.*2020). It has been concluded that an improved energy metabolism due to optimized muscle creatine supply consistently improved feed conversion ratio (Khajali *et al.*2020). A further factor sometimes contributing to a risky low Met+Cys supply is using AA matrix values for feed enzymes such as phytases, NSP-ases or proteases in feed formulation. Proteases have recently been evaluated in meta-analyses and they were found to be ineffective – at least in presence of other enzymes such as phytases (Lee *et al.*2018). Siegert and Rodehutscord (2019) concluded that published results on phytase, carbohydrase and protease on AA digestibility were highly inconsistent implying that considering matrix values would bear a reasonable risk of overestimation. The optimal dietary AA profile in general but Met+Cys : Lys in particular plays an increasingly important role at protein reduction strategy because safety margins are reduced and an increasing number of AA are performance limiting at the same time. Because of these functionalities recommendations for SID Met+Cys : SID Lys as given in Table 1 are minimum ratios but might be increased by 2-3 %-points under stressful conditions.

- **Arginine**

  As described above, **Arg** is related to Lys because both compete for the same transporters at renal reabsorption and because Lys can activate arginase (Khajali and Wideman 2010). In addition, Arg is important for immune response. In this context, Arg is a secretagogue for the growth hormone which in turn increases production of T-cells in thymus and hematopoietic cells in bone marrow. Arg also determines the activity of macrophages. Jahanian (2009) reported that the Arg requirement of starting broiler chicks for optimal immune functions (rel. bursa weight, heterophil populations and T cell response) is higher than that for maximum growth performance or feed efficiency. In addition, Arg is a precursor for nitric oxide (**NO**) which belongs to first barrier defense mechanisms. NO is also an important vasomodulator and would especially be important for higher blood circulation at high ambient temperatures (Khajali and Wideman 2010). Increasing challenge with *Eimeria species* decreased blood Arg and increased blood ornithine levels indicating that this AA is especially needed for maintaining health (Rochell *et al.*2016).

  Arg is also required for creatine formation because guanidinoacetic acid is synthesized from Arg and Gly and is then methylated to creatine. Especially in wheat based broiler feed and also in low protein diets, Arg can easily become limiting and may thus limit growth performance (Khajali *et al.*2020; Lemme and Rodrigues 2020). AMINOChick® 3.0 recommends a SID Arg : SID Lys ratio between 103% and 106% (Table 1), however, analysis of successful low protein research in broilers suggest rather 110% (Lemme and Rodrigues 2020). Therefore, for low protein diets as well as for challenging production conditions a SID Arg : SID Lys ratio of ≥110% is recommended.

- **Threonine**

  The impact of **Thr** on gut health is known for long. Particularly the high Thr content in mucin and in immune globulins indicate its importance (Bequette 2003) and, therefore, an average SID Thr : SID Lys ratio of 65% should be seen least recommendation. Star et al. (2012) reported that broilers which were challenged with *Clostridium perfringens* could cope much better with this challenge when Thr:Lys ratios ≥ 67% were applied than with lower ratios. More recently it was concluded that particularly under low protein conditions, a higher SID Thr : SID Lys ratio would be required. Research by Hilliar et al. (2019c) but also previous research showed that protein reduction reduces Thr-dehydrogenase activity. In this context, a recent study by Chrystal et al. (2020) successfully reduced dietary protein in diets for 14-35 day old broilers but only with a dig. $Gly_{equivalent}$: dig. Lys ratio of 115% in combination with a dig. Thr : dig. Lys at 75%. Our conclusion is that under low protein conditions SID Thr : SID Lys might be increased by at least 5 %-points. The low protein research by Chrystal et al. (2020), Hilliar et al. (2019a), Lemme et al. (2019) and van Harn et al. (2018) further suggested that putting extra Thr as Gly precursor will not be very effective – if at all. So, if $Gly_{equivalents}$ become limiting other strategies such as supplementing free Gly or reducing N-excretions should be considered.

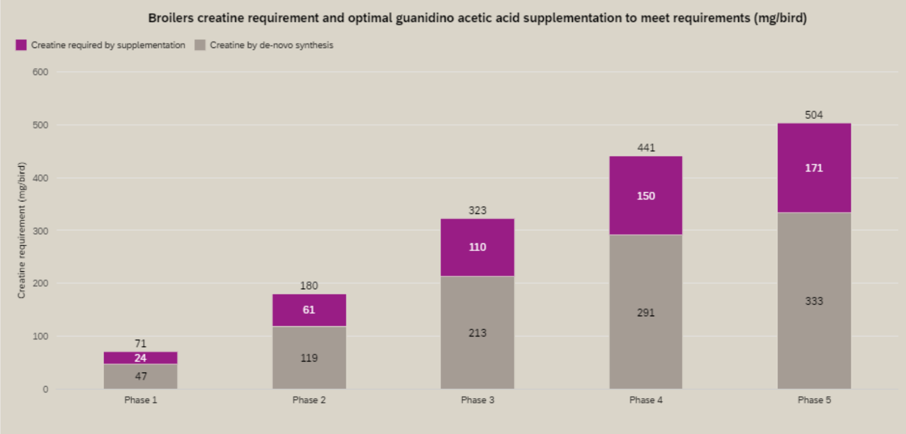

Figure 2: AMINOChick® 3.0 estimations of creatine requirement in a scenario with mixed sex broilers in a 5 phase feeding program

Creatine is a conditionally essential nutrient

AMINOChick® 3.0 estimates and reports the creatine requirement of broilers for each phase. Creatine plays a central role in the energy metabolism as it serves as an energy shuttle between the sites of ATP synthesis and utilization (Wallimann 2007). While creatine can be synthesized by the broiler from arginine, glycine and methionine, *de-novo* capacity in high yielding broilers might not be sufficient for optimal performance (Khajali *et al.*2020). Tossenberger et al. (2016) suggested that about two thirds of the demand for optimal performance can be synthesized by the chicken while the remainder should be provided with the feed. Brosnan et al. (2009) reports a de novo synthesis of creatine of a quarter to half in piglets and humans. Moreover, only feed ingredients of animal origin contain creatine but the levels are rather low and – due to processing – very variable (Khajali *et al.*2020). An alternative would be supplementation of the precursor guanidinoacetic acid (GAA). Use and efficiency of GAA in broiler nutrition is well documented (Khajali *et al.*2020). Therefore, AMINOChick® 3.0 not only estimates the creatine requirement but also suggest respective GAA supplementation for each phase (Figure 3). These recommendations are based on a similar factorial approach as suggested by Tossenberger et al. (2016). The most consistent effect of GAA on broiler performance is an improvement of FCR which is attributed to large extent to a better energy utilization. However, also better growth and meat yield was observed in meta-analyses ((Khajali *et al.*2020).

AMINOChick® 3.0 helps adjusting Met+Cys specifications in case of wrong perception of the nutritional value of methionine hydroxy analogue

AMINOChick® 3.0 includes a feature which calculates the methionine and Met+Cys specification in case of assuming a biological availability greater than 65% for the methionine hydroxy analogue products. Evonik's recommendation for this bioavailability is 65% and is based on a large number of feeding experiments (Lemme *et al.*2012). When a higher relative bioavailability is assumed, actually less methionine activity than assumed is added to the feed. Switching to DL-methionine would require an adjustment of the Met and Met+Cys specifications in order to realise full economic benefit. This feature works independent of AMINOChick® 3.0 scenarios and not only provides optimized specifications but also provides an indication about the economic benefit

Using AMINOChick® 3.0

In contrast to AMINOChick® 2.0, AMINOChick® 3.0 is an online application and requires internet access. The user can create an unlimited number of scenarios and save them. Moreover, there is the possibility to compare pairwise saved scenarios. If the user likes to get some background information, there is some help and information available.

Conclusions

AMINOChick® 3.0 provides recommendations for digestible essential amino acids and glycine equivalents which can be adjusted to various factors. In addition, it reports the creatine requirement of broilers and gives an indication for required supplementation of guanidino acetic acid. While scenarios can be defined by the user, the outcome can be saved and opened later again or compared with other scenarios. Finally, AMINOChick® 3.0 includes a tool helping adjustment of Met and Met+Cys specifications in case of switching from use of hydroxy analogue of methionine to DL-methionine.

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