Application of the Tryptophan-Biomass for Laying Hens

Abstract

In recent years, amino acids fermentation have been available for animals with specific amount of biomass in the final product (amino acids-biomass) giving a need to evaluate the responses of poultries on the expressive content of biomass in its performance. Based on this theme, two researches were defined with the objective of evaluating the two source of tryptophan for the egg production in brown egg-laying hens. The bioavailability of L-tryptophan-biomass(60% of tryptophan + 35% of biomass) was determined as 100%, presenting at the same bioequivalence of the L-tryptophan 98%. The supplementation of two source of L-tryptophan for brown laying hens presented the same performance. The result of these researches supports the importance of L-tryptophan-biomass in the diet of laying hens.

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Background

Tryptophan or α-amino-β-3-indolepropionic acid (Wu, 2013), was considered a physiologically essential amino acid by Willcock and Hopkins since 1906 who observed that the survival and welfare of the animals improved when they received tryptophan supplementation in the diet, but the tryptophan was recognized as a dietary essential component 10 years later (Osborne et al., 1916).

In recent years, amino acids fermentations have been available for animals (Wensley et al., 2020). A differentiation in these sources compared to crystalline form is based on the amount of residual fermentation biomass in the final product (amino acids-biomass).

L-tryptophan-biomass obtained by the fermentation process and after the heating steps with steam the granules are formed and, contains protein, essential and non-essential amino acids, as well as vitamins, minerals, organic acids and carbohydrates (Wensley et al., 2020) that provide additional nutrients in the feed formulation.

The manufacturing steps of this type of amino acid are shorter, resulting in a reduction production costs, bringing economic advantages to the animal production industry. Based on this, amino acid-biomass represents an economical alternative to crystalline sources (Humphrey et al. 2020), but further studies on bioavailability should be performed, justifying the measure performance of the L-tryptophan-biomass compared to crystalline source in brown laying hen's diet.

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Methods

Two studies were performed using brown laying hens at the experimental facility of the São Paulo State University (UNESP, Jaboticabal city – State of São Paulo).
All procedures were approved by Ethics Committee for the Use of Animals (CEUA) under under the Protocolnumber 3340/22.

Research 1: Bioavailability of L-Tryptophan Biomass 60% for Laying Hens

Birds and experimental design	Bird management	Experimental diets and measurements	Statistical analysis
One hundred and fifty laying hens Hy-Line Brown with 61 weeks of age were housed in the experimental facilities. The cages were equipped with individual feeders and nipple drinkers. The experimental design was completely randomized design with five treatments and ten replicates of three hens each.	**Animal** The laying hens **Conditions** Temp 22°C / Humidity 55% **Periods** 16Hour of Light by Day, 10 weeks **Parameters** Growth Performances(1,730kg) Egg Productions(82%)	**Treatment 1** BD[1](0.125% trp SID) **Treatment 2, 3** BD+Trp 98%(0.145%, 0165% trp SID) **Treatment 4** BD+Trp-Biomass 60%(0.145% trp SID) **Treatment 5** BD+Trp-Biomass 60%(0.165% trp SID) • The birds were fed with 110 g/day [1]Basal diet	The data were analysed to the assumptions of analysis of variance and normality of errors. The F test was used for the ANOVA and if the null hypothesis is rejected ($P \leq 0.05$). Also, data were analysed using the mixed model considering as fixed effects diet and experimental unity as a random effect. The relative bioavailability of L-Tryptophan 98% and L-Tryptophan-biomass 60% was estimated using slope-ratio analysis described by Littell et al.(1997), according to the model: $\xi = \alpha + \beta s Xs + \beta t Xt \pm \check{e}$, in which ξ is egg production; α is intercept; $\check{e}$ is random error; βs and βt are the slopes for L-Tryptophan 98% and L-Tryptophan Biomass 60%, respectively; Xs and Xt are the concentrations of L-Tryptophan in diet, respectively.

Research 2: Performance of Brown Laying Hens Fed with L-Tryptophan Crystalline 98% and L-Tryptophan-Biomass 60%

Birds and experimental design	Bird management	Experimental diets and measurements	Statistical analysis
Sixty-six laying hens Hy-Line Brown with 60 weeks of age were housed in the experime-ntal facilities. The cages were equipped with individual feeders and nipple drinkers. The experimental design used as completely randomized with two treatments and eleven replicates of three hens each.	**Animal** The Brown laying hens **Conditions** Temp 23°C / Humidity 60% **Periods** 16Hour of Light by Day, 16 weeks **Parameters** Growth Performances(1,763kg) Egg Productions(91%)	**Treatment 1** BD(0.172% trp SID) **Treatment 2** BD+Trp-Biomass 60% • The birds were fed with 110 g/day	Statistical analyses and estimation of model parameters were performed using SAS 9.4(Statistical Analysis for Windows, SAS Institute Inc., Cary, NC, USA) using of test F ($P \leq 0.05$).

Trial Results

The bioavailability of L-tryptophan-biomass 60% in brown laying hens is presented at the Table 1. The treatments affected ($P<0.05$) the daily tryptophan intake and the daily egg production.
The ratio of parameters analyzed (daily tryptophan intake and daily egg production) resulted in the following equations

- **L-Tryptophan 98%: Egg Production = 89.33** + 0.06693* ×Trp Intake (**P≤0.01); (*P≤0.05)**
- **L-Tryptophan-biomass 60%: Egg Production = 89.33** + 0.06701* × Trp Intake (**P≤0.01); (*P≤0.05)**

The intercept and slope were analyzed. For intercept the estimated difference for basal diet was-2.70 ($P = 0.334$). The interaction between slope and L-Tryptophan source was non-significant ($P= 0.647$). The graphic of these equations and average values of each treatment is showing at Figure 1.
The ratio of the slope of L-tryptophan 60% and L-tryptophan 98% resulted in a relative bioavailability value (RBA) of 100.13% ([0.06702÷0.06693] × 100), with confidence interval of 92% to 106%, when standard error of each parameter was used.

At the Figure 2 is showing the responses of laying hens submitted to two different diets, supplemented with L-tryptophan-biomass 60% and L-tryptophan 98% (Research 2). A basal diet diets were formulated to meet the requirement of 0.172% of tryptophan when L-tryptophan sources were added no significant differences ($P>0.05$) were found on the analyzed parameters (Figure 2).

The results support that biomass in the granular L-Tryptophan 60% did not bring negative effect on the egg production avoiding the hypothesis of presence of antinutritional factors in the final product.
The bioavailability trial did not show inferior responses of L-tryptophan-biomass 60% to crystalline form, i.e, L-tryptophan-biomass 60% is 100% bioequivalent compared to L-tryptophan 98%.

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Trial Results

Table 1. Tryptophan intake and daily egg production of the layers.

		Trp in the Diet (%)	L-Trp Supplementary (g/kg)	Daily Intake of L-Trp (mg/hen)	Daily Egg Production (%)
Treatments	T1: Basal	0.125	0	0	86.6
	T2: Basal + Trp 98%	0.145	0.204	21.5	90.7
	T3: Basal + Trp 98%	0.165	0.408	43.7	92.3
	T4: Basal + Trp-Biomass 60%	0.145	0.333	21.7	92.0
	T5: Basal + Trp-Biomass 60%	0.165	0.667	43.5	92.1
Average				26.1	90.7
Stderr				0.5	0.7
P-value				<0.0001	0.041
Coefficient of variation, %				2.05	4.97

Figure 1. Bioavailability of L-tryptophan-biomass 60% compared to L-tryptophan 98% based on egg production by slope-ratio linear-model

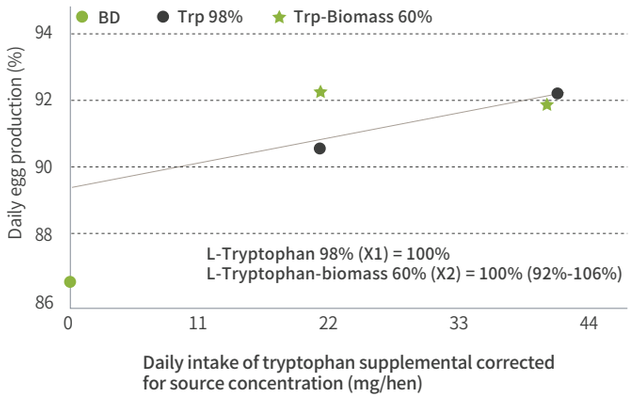
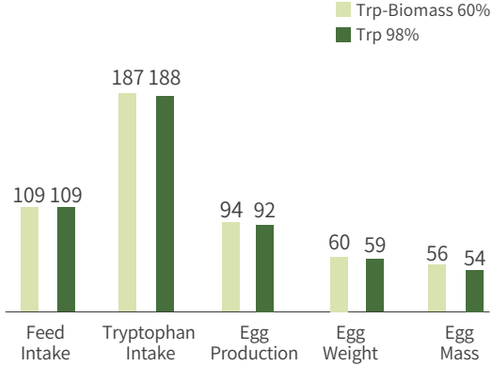


Figure 2. Responses of brown layers to sources of tryptophan (P>0.05)



Conclusion

The bioavailability of L-Tryptophan-biomass 60% is 100% compared to L-Tryptophan 98%.
In conclusion; both sources of L-tryptophan bring the same bioeq-uivalence in brown laying hens in the production phase.
Also, brown laying hens fed with diet to meet 0.172% of tryptophan SID with both source of tryptophan presented the same performance.

References

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