Glutamine; essential or not?

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Glutamine (GLN) is not in the list of essential amino acids, but there has been a lot of research about this amino acid and seems to be important for many metabolic processes in the body. So what is the story behind glutamine? Is it essential or not?

Traditionally glutamine is considered to be non-essential. The definition of an essential amino acid is as one that the body cannot synthesize in sufficient amounts (Rose et al., 1948). There is increasing evidence that glutamine is limiting during key phases like pregnancy, lactation and neonatal growth (Wu, 2010).

How does it work?

Glutamine can be made in the body from glutamate and ammonia, primarily in skeletal muscle, lungs, adipose tissue and liver. Glutamine is needed for a lot of biosynthetic pathways, mainly for growth and cell division.

In healthy animals (i.e. no stress or in negative energy balance) the body is able to make glutamine and there is no shortage. However, 25 years ago, in human they discovered that glutamine requirements in certain physical status (wound-healing, immune system depression, post-surgery) can be greater than the body can synthesize (Wernerman, 2008). Studies have shown benefits to supplement glutamine to those patients (Wang et al., 2010). Additional studies have identified that young and gestating mammals cannot synthesize sufficient amounts of glutamine to support growth and intestinal health (Wu et al., 2010).

Nowadays the beneficial effects of supplementing glutamine in nutrition are well-studied. There have been performed a major number of studies looking at dietary glutamine in both animals and humans (in both adults and young), showing that glutamine has positive effects among others on oxidant status, bacterial translocation, immunity status, nitrogen balance and muscle development (see Figure 3).

Main reason why glutamine is especially beneficial for young animals is because glutamine is the preferred fuel of intestinal tissue (Figure 2) and immune system (Curi et al., 2007). Young animals are still growing, have an immature gut and suppressed immunity. In this article, the focus will be narrowed to the effect of glutamine on the intestinal health and immunology in young animals.

Glutamine supplementation in young animal diets

Supplementing glutamine to a conventional diet - that was traditionally thought to provide adequate levels- can maximize growth in young animals and prevent diseases (wu, 2009-2010; Yi et al., 2005). This has primarily to do with the positive effect of glutamine on the development and growth of enterocytes. Studies show that enterocytes use glutamine as the main energy source (McCauley et al., 1998), promoting growth and proliferation (Yang et al., 2000).
With this, not only nutrient utilization is improved, but also gut integrity. Since better developed enterocytes reduce bacterial translocation (which is passage of bacteria from gut lumen through the blood to the rest of the body) (Berg, 1999).

This confirms a protective role for glutamine in intestinal integrity, providing fuel for the enterocyte and therefore as a preventive mechanism of infections and disease (Leguina-Ruzzi, 2015). Secondly, glutamine removes oxidants and promotes immune activation (Wang et al., 2008). This is also confirmed by Yi et al. (2005), they show that supplementation with glutamine in broiler starter feed results in a better gut morphology and immune response (Table 1). They raised 720 Cobb broilers with either a control starter diet (4.23% gln) or a 1% glutamine supplemented starter diet.

Table 1. Impact of glutamine on performance and immune response (Yi et al., 2005).

<table>
<thead>
<tr>
<th></th>
<th>Weight d14</th>
<th>FCR 0-14</th>
<th>Livability d14 (%)</th>
<th>IFNo d14 (ng/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>386a</td>
<td>1.23</td>
<td>97</td>
<td>181a</td>
</tr>
<tr>
<td>Glutamine</td>
<td>416b</td>
<td>1.18</td>
<td>100</td>
<td>154b</td>
</tr>
</tbody>
</table>

Longer villi in the small intestine increase nutrient absorption efficiency in a chicken’s early life and result in better results as a broiler. Several studies show that extra glutamine in the diet increases villi length in different parts of the small intestine (Soltan, 2009; Ebadiasl, 2011).

Not only in poultry, but also in swine there is tremendous evidence of the positive effects of dietary glutamine. Feeding glutamine is effective in coping with an E. coli challenge in swine. Piglets fed glutamine had a higher villus length and better intestinal morphology after an Escherichia coli challenge at 12 days post-weaning compared to the control group. Supplementing glutamine helps to prevent a pathogenic infection and promotes maintaining a normal intestinal integrity and function (Yi et al., 2005; Pardo et al., 2014). Feed conversion improved with increased levels of additional glutamine for challenged piglets with E. coli (Pardo et al., 2014).

Weaning is a stressful phase in a pigs’ life and can directly affects the intestinal morphology. It is shown that glutamine can help to prevent and/or recover this gut damage caused by weaning. Liu et al. (2009) show a decreased villi atrophy in piglets during the first week post-weaning with 1% extra glutamine vs. a control corn / soya diet. This is in line with the findings by Wang et al., 2008. They measured the villi length when suckling (269 μm) versus weaning with a control diet (265 μm) vs a glutamine- enriched diet (371 μm).
Zou et al. (2006) found, next to a lower diarrhea incidence (see Figure 4), a significantly improved FCR (-12%) and increased growth (+28%) post-weaning with 1% supplemented glutamine during the first 20 days post-weaning.

A typical corn- and soybean meal-based diet cannot provide sufficient amounts of glutamine for protein accretion in post-weaning piglets (Wu, 2010), so to reach the maximum potential extra glutamine is essential.

**Summarizing**

While the body can make glutamine, it is considered a conditionally essential amino acid (Wu, 2009). That means it’s essential in the diet under certain conditions, including illness and stress and for young animal. During these times higher levels of glutamine are beneficial. The findings of multiple studies show beneficial effects of dietary glutamine supplementation to improve the status of young animals (Wang et al., 2008). Supplementing glutamine enhances immune function, prevents intestinal atrophy and improves growth performance in weaning piglets and broiler chickens.
References


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