Growth-promoting antibiotics in broiler diets enhance production and offer numerous benefits, including increased breast yield, improved average daily gains and better feed conversion. Yet, even after 50 years of use in animal production, researchers still debate the exact mechanisms which produce these positive results. Now, recent bans on feeding antibiotics at sub-therapeutic levels in the European Union and elsewhere are forcing feed manufacturers both inside and outside the EU to seek other ways to maintain production and animal health.

However, no single solution seems forthcoming. Mixed in with the extraordinary array of ‘all natural’ substances that seek to replace antibiotics, there is copper (Cu)—in a couple of simple forms for use as a feed additive. Supplemental copper in poultry diets deserves renewed attention because it can have positive effects on bird health and immunity. Copper may be especially useful where the use of antibiotics as growth promoters is curtailed.

Copper is vital in the body as a component or cofactor in enzyme systems involved in iron transport and metabolism, red blood cell formation and immune function. It is involved in both cell-mediated immunity (helping to eliminate invading bacteria) and humoral immunity (helping to produce antibodies). These and other functions make copper even more essential where antibiotics are either limited or banned in diets completely.

Reducing stress effects
Stressful conditions like transport, vaccination, diet changes and temperature fluctuations can lower a bird’s immunity and cause pathogenic changes in the gastrointestinal microflora. This may result in illness and death, but at a minimum redirects energy and nutrients away from growth and development. Many nutritionists and veterinarians believe antibiotics prevent stress upsets by promoting and maintaining a homeostatic environment in the intestinal tract.

Copper can contribute to intestinal health in two ways. As an antimicrobial agent, copper can prevent disturbances in the balance of microflora. It can also help the gut respond to infections, injury and inflammation. Copper is involved in protecting cells from free radical damage as a component of superoxide dismutase and copper enhances iron transport as part of ceruloplasmin.

The required levels of essential minerals like copper can vary depending upon the severity, duration and type of stress experienced by an animal. Broiler nutritionists can more effectively maximise productivity and health by taking these relationships into consideration.

Lowering disease challenges
In his in-vitro study conducted at the

Table 1. Antimicrobial effect of two copper feed additives.

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>E. coli</th>
<th>Salmonella spp.</th>
<th>Campylobacter spp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>&gt;500 colonies</td>
<td>&gt;500 colonies</td>
<td>&gt;100 colonies</td>
</tr>
<tr>
<td>TBCC¹</td>
<td>50 colonies&lt;100</td>
<td>200 colonies&lt;300</td>
<td>50 colonies&lt;80</td>
</tr>
<tr>
<td>Copper sulfate</td>
<td>200 colonies&lt;300</td>
<td>400 colonies&lt;500</td>
<td>60 colonies&lt;80</td>
</tr>
</tbody>
</table>

¹Tribasic copper chloride.
Source: J. Cohen after J. McNaughton, PARC Institute, 1999.

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PARC Institute in 1999, Dr. James McNaughton demonstrated the antimicrobial action of two forms of copper. The microbial screening procedure involved solutions containing strains of E. coli, salmonella species or campylobacter species sourced from the intensive poultry production region in the USA known as DelMarVa (Delaware, Maryland and Virginia). The bacteria were combined with 250 ppm copper from either copper sulfate or tribasic copper chloride (TBCC). Treated bacteria samples were incubated for 24 hours on MacConkey and blood agar plates.

By lowering disease challenge, supplemental copper can help ensure that a greater portion of a bird’s finite quantity of available energy will be directed towards growth and development, rather than fending off disease.

Included in almost every trace mineral premix is enough copper to satisfy the minimal nutritional requirements of broilers and turkeys. It has become a common practice in the USA and elsewhere to supplement these diets with 125 to 250 ppm additional copper to enhance bird health and well-being. While nutritionists debate exactly how copper accomplishes this enhancement, its use is widespread.

Broilers under stress appear to benefit from increased copper, depending upon the stress applied. Trials described by Dr. Danny Hooge at the International Poultry Scientific Forum in 2000 indicate that the level of copper needed for optimum performance becomes progressively higher with increased stress (Figure 1). Dr. Hooge’s work also showed that extra copper yielded improvement over the controls for all body weights.

**Antioxidant effects**

Oxidation of lipids, fatty acids and fat-soluble vitamins in feed products can have a negative impact on feed quality and palatability, ultimately reducing feed intake, performance and overall health status. Vitamins are particularly susceptible to degradation in premixes and during feed processing and storage. Copper can promote bird health and growth by helping to preserve dietary components that are prone to oxidation.

Research at PARC Institute in 1997 showed a significant difference in the losses of vitamin E during pelleting when higher levels of copper were added to broiler feeds. Control diets contained only the basal amount of copper (12 ppm) from copper sulfate in the mineral premix while the other treatments contained 250 ppm copper from TBCC. In this research, vitamin E activity was measured in serum samples and expressed as a percentage of the level in the unpelleted diet. Vitamin E losses at 21 days were greater than 26% in the control diets, but less than 10% in the diets containing 250 ppm copper.

**Environmental impact**

Just as the scrutiny of antibiotics in animal production is increasing, so too there is greater attention to trace mineral levels in manure. Environmental concerns regarding application of excessive levels of trace minerals such as phosphorus, zinc and copper demand attention by nutritionists.

In the case of copper, it is important to use sources that are readily bioavailable so that lower levels of copper can deliver the desired benefit (Figure 2). Supplemental copper sources also behave differently after deposition in the environment as manure or litter. For example, work with chicken droppings to simulate agricultural run-off potential suggests that TBCC can reduce leachable copper in the range of 15-32% versus copper sulfate.

Copper can play a strategic role in poultry health and growth. It can serve to reduce disease challenges and boost immune function. However, there are differences among sources of supplemental copper for both the bird and the environment. Feed manufactures should take care to use copper and other mineral sources that will maximise animal health while minimising the mineral output in waste.