REFLUX OF DIGESTA AND ITS IMPLICATIONS FOR NUTRIENT DIGESTION AND BIRD HEALTH.

A. SACRANIE\textsuperscript{1}, P.A. IJI\textsuperscript{1} and M. CHOCT\textsuperscript{1}

Summary

Reflux is the anti-peristaltic induced, retrograde movement of digesta in the gastrointestinal tract (GIT). Previous research has characterized the occurrence and frequency of reflux, as well as the possible effects it has on the well-being of the chicken. Reflux may be both beneficial or harmful depending on the general health of the bird. In a healthy bird, it may present the opportunity for prolonged exposure of digesta to the enzymatic and mechanical systems of the GIT, thus leading to an increase in digestion and absorption time in the upper intestine. On the other hand, pushing caecal contents up into the intestine may increase the chance of undesirable organisms colonising the intestine, possibly resulting in subclinical infections. Another important implication of digesta reflux in chickens may relate to the use of the marker technique for determination of ileal digestibility of nutrients since the technique assumes constant, one-way flow of digesta throughout the GIT. This paper presents a brief review on the digesta reflux phenomenon and speculates how reflux could affect the general health of the chicken and how it may be manipulated by diet.

I. INTRODUCTION

The growing broiler obtains the necessary nutrients from feed, via a series of enzymatic reactions that hydrolyse the macromolecules of the feedstuffs into a form that can be absorbed into the blood and then transported throughout the body. During this complex process, food is travelling along the GIT and a proportion of it may be lost through excretion before digestion and absorption are complete. Loss of nutrients through excretion depends on a variety of factors including, the nutrient composition of the diet, the characteristics of the microbial population in the GIT, which may be both harmful and beneficial, competing for nutrients. Loss of nutrients through excretion is difficult to prevent but digestion and absorption may be slowed by the reflux, reverse peristalsis, of material from the lower GIT backup into the gizzard.

II. THE OCCURRENCE OF DIGESTA REFLUX IN THE CHICKEN

The phenomenon of reflux of duodenal contents into the gizzard has been widely accepted for over thirty years (Duke et al., 1972). In fact, the brownish colour of the gizzard cuticle is believed to be due to the reflux of bile pigments from the duodenum (Sturkie, 2000). Basha and Duke (1999) have carried out extensive studies on gastric and duodenal motilities of turkeys. Their research focused on the small intestinal reflux, which refers to the antiperistaltic contractions moving intestinal contents into the gizzard. Evidence of this was first obtained through the cineradiographic studies of Dziuk and Duke (1972), in which it was reported that the contents of the upper small intestine of adult Wrolstad turkeys were refluxed in the muscular stomach at irregular intervals. Additional evidence for the existence of

\textsuperscript{1} School of Rural Science & Agriculture, University of New England, Armidale, NSW 2351 - Australia
retrograde movement of digesta was provided through the examination of marker
distribution throughout the GIT (Oguro and Ikeda, 1974), measurement and
characterization of smooth muscle electrical pulses (Roche and Ruckebusch, 1978;
Martinez et al., 1995a, b; Jimenez et al., 1994) and analysis of digestive enzyme
distribution along the GIT. The small intestinal reflux is a result of paired high-
amplitude duodenal contractions that propagate orally at a high velocity. Gastric
activity dies down during this period and then rapidly recovers to normal gastric
activity (Duke et al., 1975).

Clench and Mathias (1992) and Jimenez et al. (1994) characterized a unique gut
motility response to fasting in chickens. Fasting appeared to enhance antiperistaltic
motility in the GIT, and extended fasting resulted in a characteristic motility pattern
labelled a “rhythmic oscillating complex” (ROC). ROCs are highly organized motility
patterns that spontaneously occur in fasted birds and often during periods of darkness.
ROCs last approximately six minutes and consist of four consecutive patterns of spike
bursts progressing in an oral direction. The result of an ROC is the re-establishment of
motility patterns in the stomach and duodenum associated with satiety for a short
period of time. It has been postulated that ROCs are a mechanism by which birds can
recycle food from the caeca or distal intestine, therefore maximizing its nutrient
resources, during fasted periods (Clench and Mathias, 1992). There are similarities
between small intestinal reflexes (SIRs) in turkeys and ROCs in chickens.

III. IMPLICATIONS OF DIGESTA REFLUX FOR NUTRIENT DIGESTIBILITY

The benefits of digesta reflux have not been firmly established, and the
phenomenon has been generally less studied in poultry, perhaps due to their size (Duke,
1982). In turkeys, intestinal reflux appears to enhance nutrient utilization (Basha and
Duke, 1999). Reflux has been clearly characterized in fasted animals but as yet little
work has been carried out investigating the effects different diets may have on motility
patterns. Hetland et al. (2003) found that chickens fed a high fibre diet showed an
increase in the concentration of bile acids in the gizzard suggesting increases in
gastrodoudenal reflux. Sklan et al. (1978) have reported a rapid rate of reflux from the
duodenum to the gizzard. Digestive enzymes and bile salts, usually associated with the
duodenum were also found in the gizzard at lower concentrations. Such factors would
facilitate the digestion of nutrients in the gizzard, resulting in an increased availability
of nutrients to the bird. A major difference suggested was that duodenal-gizzard reflux
was more rapid and continuous in the chicken than in turkeys (Sklan et al., 1978).
Retrograde movement of duodenal contents to the gizzard re-exposes the feed, now
mixed with and partially digested by pancreatic enzymes, to the enzymatic systems of
the gizzard and the change in the pH reactivates peptic digestion. The shuttling of
digesta between the gizzard and duodenum increases the time the feed is exposed to
digestive enzymes and absorption in the upper intestine is favoured by retrograde
movement. This theory would explain why high fibre diets appear to induce an
increase in reflux, maximizing the nutritive value of the robust feed.

It is likely that similar events would arise when other feed factors that are not
digested by animal enzymes are present in the diet. Such factors, including fibre (non-
starch polysaccharides) are high in temperate cereals such as wheat, barley, oats and
rye. Wheat constitutes a considerable proportion of poultry diets in Australia. Wheat
quality, particularly on account of non-starch polysaccharides (NSP) in Australia is
very variable between years and regions (Annison, 1993; Chocet et al., 1999; Hughes
and Chocet, 1999). This variation is partly responsible for the wide differences in
individual productivity among poultry flocks. Australia is also the leading producer of lupins and many other legume seeds, which are included as alternatives to soybeans in poultry diets (Pettersson and Mackintosh, 1994; Hughes et al., 2000). These seeds are rich in raffinose-series oligosaccharides, factors that cannot be digested by animal enzymes. Apart from these anti-nutritive factors, the effects of regular nutrients such as protein and fats on digesta reflux have not been previously investigated. Poultry diets vary from one growth phase to another, as does the nutrient composition of diets that are use by industry. Such variation is known to affect the productivity of poultry. Previously, knowledge of the mechanisms involved in growth discrepancies has been limited to relationships between different nutrients, nutrient deficiencies and imbalances. No investigations have been made as to the role of changes in pattern of digesta reflux on feed utilization. Infusion of fatty acids, triglycerides and complex carbohydrates into the ileum results in an "ileal brake", delaying gastric emptying and intestinal transit time (Martinez et al, 1995a). This mechanism is associated closely to gastric motility and is an adaptive response to ensure complete digestion and absorption of the meal in species with shorter GITs. This mechanism has been more closely studied than reflux but it is possible that they share similarities in that they both appear to be a reaction to complex diets, with the aim of obtaining the maximum nutritive value from the feed.

III. IMPLICATIONS OF DIGESTA REFLEX FOR THE HEALTH OF CHICKENS

The proportions of different microbial species and their location within the GIT of poultry have been previously studied (Apajalahti et al., 2001). Some of these species, e.g. Lactobacilli are beneficial, but some strains of species such as Salmonella, and Escherichia coli can be pathogenic. Normal peristaltic movements are able to move species from the upper GIT to the lower gut, but antiperistalsis (digesta reflux) has the opposite effect and it is not known to what extent this will pose a health risk. It is envisaged that organisms carried in the refluxed digesta may colonise the upper part of the tract if the conditions are right. For example, in birds fed diets based on non-viscous grains, such as corn and sorghum, there is little fermentation in the small intestine. However, when they are fed diets based on viscous grains, such as wheat, barley and rye, fermentation in the small intestine increases rapidly (Chocot et al., 1996). When digesta viscosity increases, digesta passage slows down and oxygen tension in the intestine decreases, creating a relatively stable environment with a low level of oxygen for anaerobic microflora to establish (Smits et al., 1998). The implications of such a change are many, including proliferation of pathogens and changes in nutrient utilisation.

IV. CONCLUSION

It is evident that reflux occurs, but the extent and pattern of reflux in different classes of poultry are not understood. In addition, identification of dietary factors that influence reflux is of practical significance as the information may be used to formulate diets that take advantages of its positive aspects and avoid the negative side.
REFERENCES