DIETARY FIBRE - THE FORGOTTEN NUTRIENT?

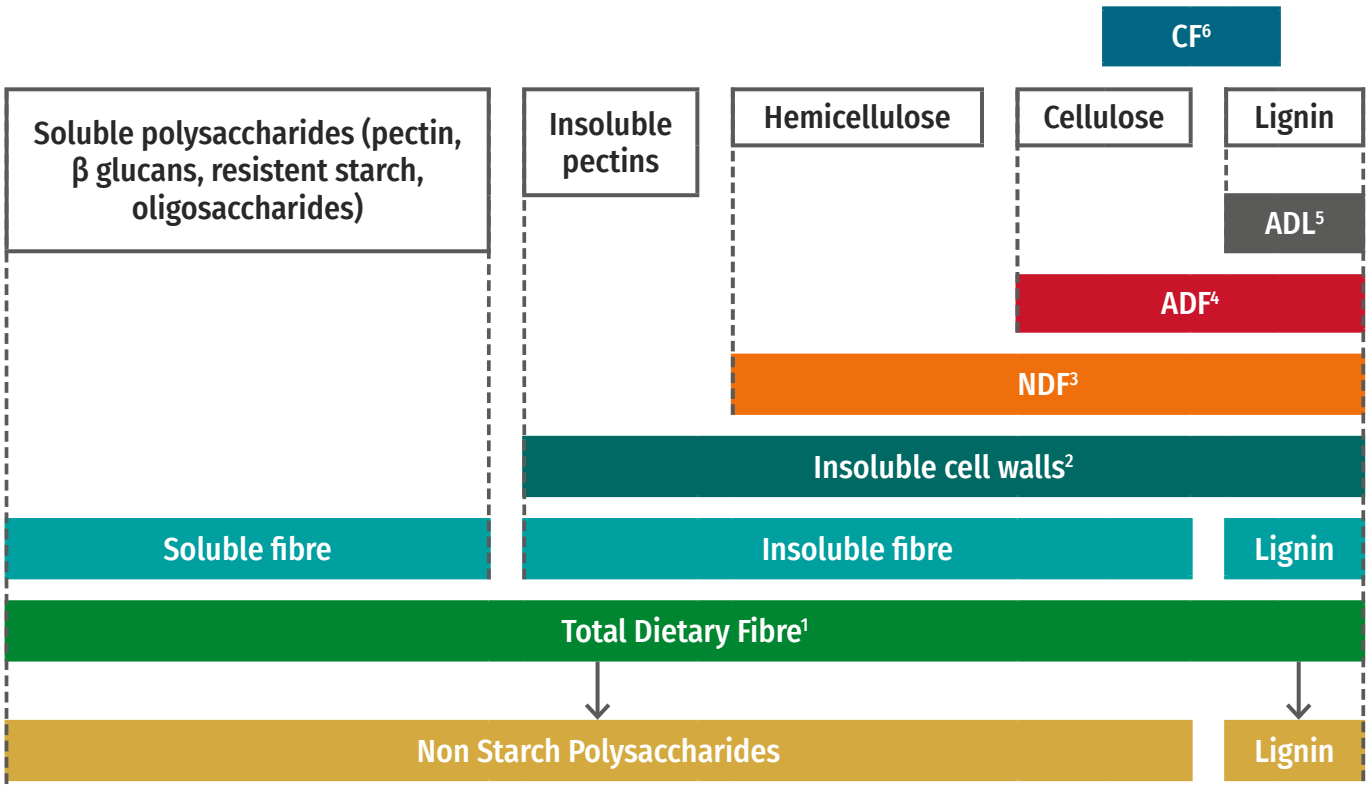
INTRODUCTION

In poultry nutrition, high fibre ingredients have historically been associated with negative attributes such as energy dilution of the diet and potential mycotoxin contamination. Usually, these ingredients were not included or their use was limited during feed formulation.

However, many are now reconsidering fibre for poultry to meet two objectives. First to have a positive effect on the intestinal microflora and intestinal health and secondly, for possible benefits from energy dilution using reliable fibre sources for the management of breeders.

BACKGROUND

Dietary fibre has been described as the skeletal remains of plant cells in diets that are not digested by monogastric animal. Fibre is a nutritionally, chemically and physically heterogeneous material comprising many components. Crude fibre is a very old method of analysis used to estimate fibre by measuring some of these components mainly cellulose and lignin after harsh chemical treatment of a sample. **Crude fibre** analyses were not consistent in the types of fibre recovered and excluded many important soluble non-starch polysaccharides (NSP's) and not easy to relate to physiological functionality (figure below).



NDF: Neutral Detergent Fibre
ADF: Acid Detergent Fibre
ADL: Acid Detergent Lignin
CF: Crude Fibre

[1] Prosky et al., 1992 (AOAC)
[2] Carré et Brillouet, 1989
[345] Van Soest et al., 1991
[6] Weende method (AOAC, 1984)

According to Dégen et al., 2007

Fibre analysis methods

A better way to describe this heterogeneous mix is to broadly categorize the fibre components into two major subclasses i.e., water **soluble** (viscous and fermentable fibre) including soluble NSP's and **insoluble** (non-viscous and non-fermentable sources) including insoluble NSP's and lignin. Differentiation of soluble and insoluble fibre components has helped elucidate some of the physiological effects of fibre as the two subclasses have different roles in the digestive/absorptive processes within the gastrointestinal tract (Table 1).

TABLE 1: SOLUBLE VERSUS INSOLUBLE FIBRE

SOLUBLE FIBRE	INSOLUBLE FIBRE
➨ Reduces intestinal passage rate.	➨ Structural fibre.
➨ Reduces digestion of fat, protein and starch.	➨ Accumulates in the gizzard and regulates digesta passage.
➨ Binds nutrients (pectin).	➨ Increased intestinal passage rate.
➨ Affects viscosity of the digesta.	➨ Improves starch digestibility.
➨ Mainly fermentable parts.	➨ Poorly fermentable and minimally degraded by the gut microflora.
➨ Energy source for monogastric animals.	➨ Stimulation of intestinal villi. Unidentified growth factor?
➨ Reduces dry matter of faeces contributing to production and sanitary problems.	➨ No energy source for young monogastrics.
	➨ Increases dry matter content of faeces.

It is important to note that the negative results reported for some ingredients high in soluble NSP's can be targeted with enzyme supplementation and with feed processing designed to suit the requirement of the specific fibre type and age of bird. Reducing the risks associated with soluble NSP's allows more focus on the benefits of insoluble NSP's.

The amount and also the structure of insoluble fibre is very variable between different ingredients and between different samples of the same ingredient (Table 2).

In addition to high fibre ingredients that are used for dilution of the nutrient content, there are some inert materials that can be added to the diet with no nutrient contribution. These are usually based on silica products.

TABLE 2: VARIOUS HIGH FIBRE AND INERT INGREDIENTS

FIBRE			INERT MATERIALS
INSOLUBLE	SOLUBLE	CONCENTRATED	
Wheat straw Rice Bran Oat Hulls Sawdust Shavings Lucerne Hay	Sugar Beet Pulp Citrous Pulps Grape Pulps Soya Hulls	Concentrates of specific fibre components	Sand Kaolin Diatomaceous earth

ROLE OF INSOLUBLE FIBRE HIGHLY DOCUMENTED IN BROILER BREEDERS

1. Better nutrient availability

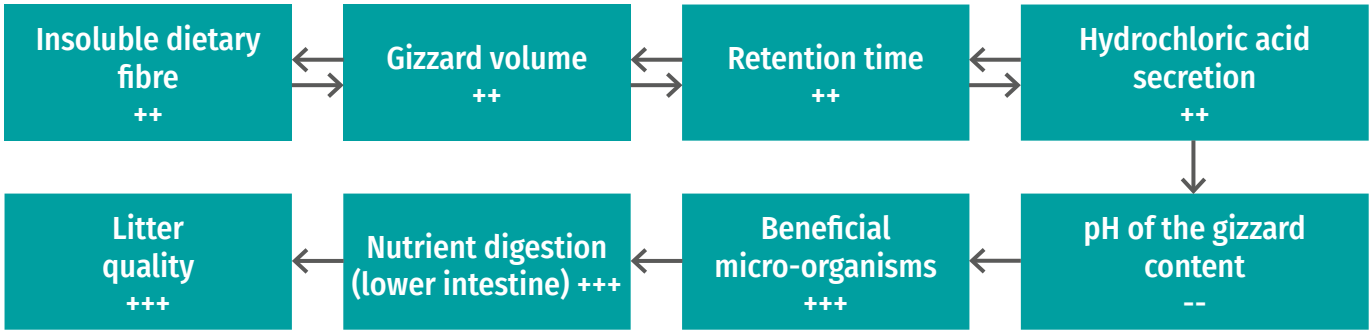
The insoluble fraction used to be considered as performing an exclusively nutrient dilution role and otherwise to be nutritionally inert for poultry. However, many studies report that insoluble fibre (insoluble NSP's and lignin) affects gut function and modulates nutrient digestion in different ways:

- The insoluble fraction fibre accumulates in the gizzard, resulting in a better development of the gizzard.
- The improvement of the grinding capacity of the gizzard reduces the amount of coarse particles entering the small intestine contributing to an increased nutrient availability and nutrient utilization and a controlled rate of passage.

2. Prebiotic role

High-starch diets favour fermentation in the small intestine where pathogens can quickly multiply, creating a situation with a high risk of microbial imbalance and intestinal disease in the host.

Published studies also provide that insoluble NSP's may serve a prebiotic role to increase the growth of beneficial bacteria that stimulate both intestinal and overall health status by stimulating production of some volatile fatty acids.



Mode of action of the insoluble dietary fibre

Insoluble fibre may also play a role in helping maintain the synchronized proper functioning of the caeca and upper colon. The sorting and reflux of digesta material back to the caeca is a complex process and insoluble fibre may play a key role in modulating this process.

3. Behaviour

In addition to other factors such as feed presentation, mineral and amino-acid balance, it has been shown in various studies with breeders that feeding high fibre and low energy diets, or supplementary roughages may reduce or prevent abnormal behaviours and improve feeding behaviour.

However, addition of fibrous structural components may also be deleterious to performance at too high levels because of the risks for reduced nutrient intake and absorption. Special care needs to be taken when reducing the dietary ME content below 2500 kcal/kg as this will require high inclusion of diluent feed ingredients.

LOW DENSITY POULTRY DIETS: FIELD EXPERIENCE IN BROILER BREEDER DIETS

Modern broiler breeders can be characterized by a developed appetite and efficient feed utilization. Attempts to feed broiler breeders with diluted and high fibre diets to increase volume satiety during the rearing period is receiving more attention today due to potential improvements in managing body weight uniformity by allowing access to a greater volume of feed with easier distribution and benefits to bird welfare.

Published research and some field experiments support that low ME diets fed in the rearing period may help to:

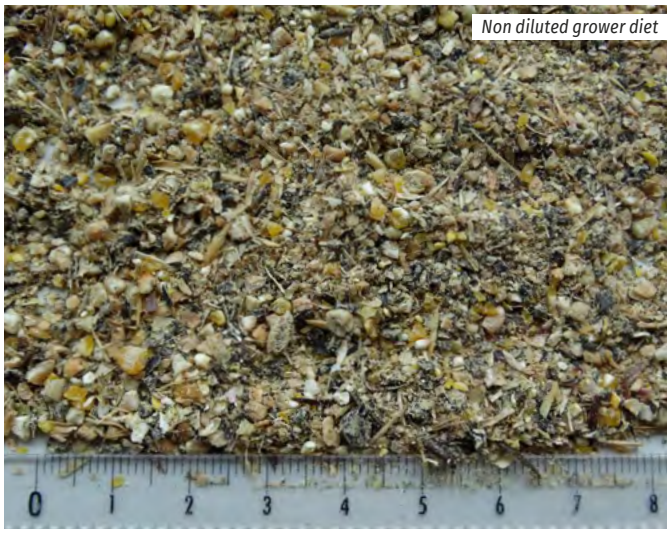
- promote flock uniformity;
- delay the development of the reproductive tract;
- increase early egg size in some cases but not all.

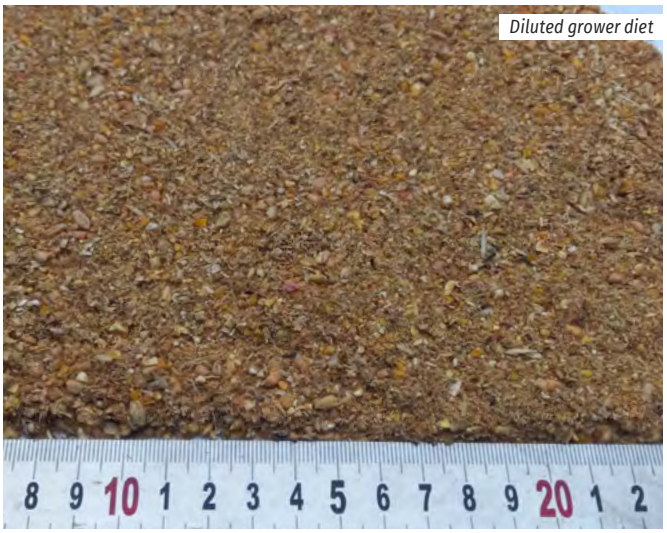
Other studies with low density broiler breeder diets fed during lay showed:

- increase in egg and day-old chick weight in some cases but not all;
- improved growth rate;
- reduced mortality in the broiler progeny (Enting et al 2007).

Hubbard has undertaken internal field trials using grower and breeder diets ranging from 2400 to 2620 Kcal ME/kg diet (See pictures below) which showed:

- an increased feed clearance time by 5-15 minutes in rearing and 30-90 minutes in production according to the degree of dilution applied;
- easier achievement of a correct flock uniformity;
- better control of feed distribution and feeding behaviour (two feed distributions a day in the production period);
- calmer birds and a reduced risk of feather licking;
- positive drinking behaviour (no controlled access to water);
- easier control of the litter quality (dryer litter).





POINTS OF ATTENTION AT FARM LEVEL

Some critical points need to be emphasized when making changes to dilute dietary ME in broiler breeders:

- For all high fibre diets, it is essential that the growth of the broiler breeders remains in the range recommended for the breed.
- When feeding low energy diets to breeders it is important to compensate for the lower energy concentration by increasing feed intake. However, the feed allocation should always be adjusted according to the evolution of the bodyweight.
- It is also important that water is sufficiently available to allow swelling of the feed to aid the feeling of satiety from gut fill but not to cause issues with gut compaction or constipation especially at high inclusion of high fibre ingredients.

- Special attention needs to be paid to the transitional phases between diets especially when the feed is changed from a high-density starter ration to the diluted grower feed allocation. Also be careful when returning to the normal density breeder ration (especially when grower diets are less than 2500 Kcal/kg). In general, do not increase the dilution effect and decrease the ME content of the diet after 16 weeks of age as the bird transitions through the Grower, Transition and Breeder diets.
- Variable ME content of ingredients from batch to batch makes accurate allocation of feed amounts more difficult. Variable nutrient intake may affect uniformity. Weekly growth must be carefully monitored and feed amounts adjusted accordingly.

POINTS OF ATTENTION FOR FORMULATION

Different fibre sources have different and sometimes very high-water holding capacity (WHC) that is important to consider when choosing high fibre or inert ingredients. The swelling effect with high water holding capacity ingredients has a major effect on limiting volume feed intake and potentially may limit the ability of birds to eat increased amounts of feed to maintain nutrient intake (Table 3).

TABLE 3. WATER HOLDING CAPACITY OF VARIOUS FEED INGREDIENTS (NASCIMENTO ET AL, 2021)

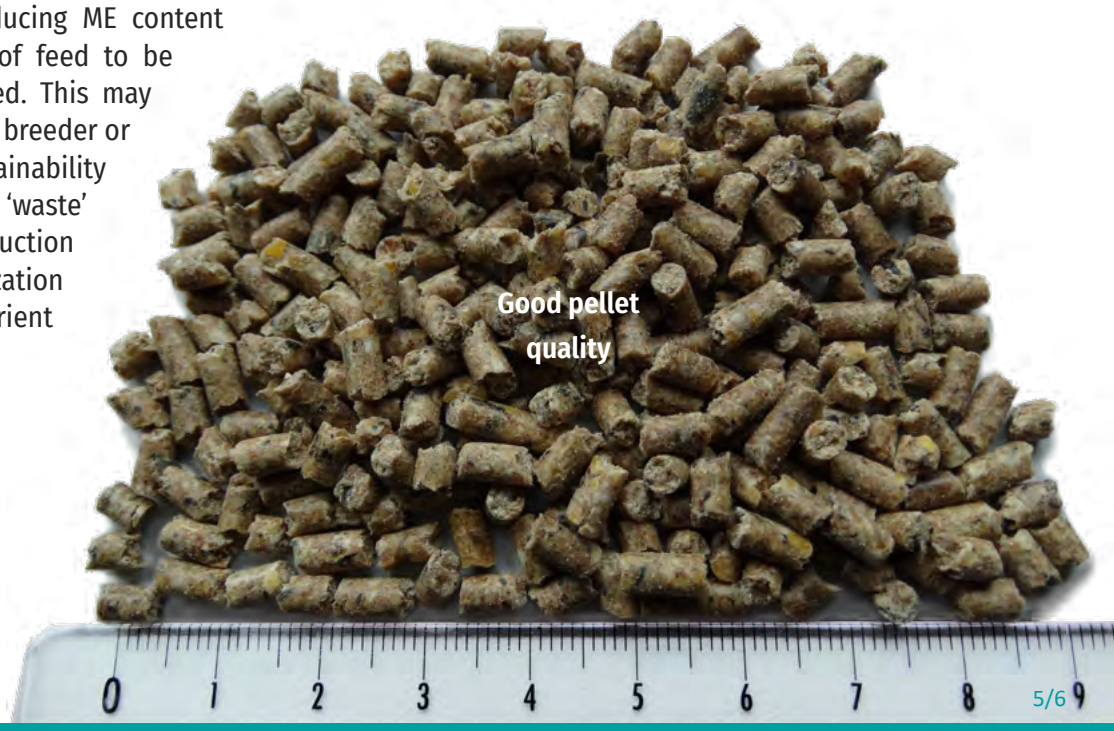
FIBRE SOURCE	WHC (g/g)
Cellulose Fibre	7.95
Sawdust	6.5
Rice husk	5.5
Sand	4
Vermiculite	8.5

- Key points for diet formulation:
  - Inert materials should not exceed 5% of the diet considering their potential very high WHC.
  - Some fibre sources may contain more phytate bound phosphorus so the use of phytase enzymes needs to be reviewed with the phytate content of the diet in mind.
  - Formulating diets needs to consider a wide range of essential amino acids for which digestibility may be more variable so ensure formulation is made on a digestible basis.
  - High fibre ingredients may concentrate mycotoxins, so this risk needs to be assessed.
  - Some ingredients like rice bran are abrasive and can cause gut irritation and possible enteritis.

- When using mash feed, it may be difficult to get a uniform coarse mash when using very fine raw materials such as wheat bran. Careful preparation of the added fibre source should be considered such as a coarsely ground straw. In Hubbard trials, good quality processed wheat straw has been added at up to 20% in Grower and Breeder mash diets.

- If pelleting for diets used in daily spin feeding the amount of added fibre may be limited to maintain pellet quality (see image on the right). In Hubbard trials the addition of good quality wheat straw had to be limited to 10% or less to maintain pellet quality. This will vary according to each ingredient.

- Diluting the diet and reducing ME content increases the total amount of feed to be manufactured and transported. This may increase total cost of feed per breeder or chick and impact other sustainability metrics. However, the use of 'waste' feed ingredient in poultry production may help improve overall utilization of nutrients in a circular nutrient chain.



SUMMARY AND PERSPECTIVES

Dilution of diets in rearing and possibly in production is a strategy to help where feed distribution is preventing good uniformity being achieved and may help alleviate abnormal behaviours. It may make feed distribution and drinker management much easier leading to calmer flocks.

Insoluble fibre may help improved gut function with better gizzard function affecting gut retention times and may provide a prebiotic effect. Typical inclusion rates for inert materials are less than 5%. High fibre ingredients inclusion rates vary according to risk but typically are limited to a maximum of 10% for most high fibre ingredients or 20% if known ingredients with consistent quality are used like processed wheat straw.

The risks of ingredient availability, nutrient variability, water holding capacity, mycotoxins and cost should be considered when attempting diet dilution or using high fibre ingredients.

It is also important to recalculate the required amount of diluted feed to ensure target nutrient intakes are met remembering the priority that the feed allocation is adjusted so the birds achieve the target body weight and weekly growth rates in the rearing period.

References on request.

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