Composition of Barley

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Barley (*Hordeum vulgare* L.) is one such feed ingredient, the use of which remains limited in poultry diets due to its low metabolisable energy, presence of anti-nutritive, soluble non-starch polysaccharides and consequent inter-cultivar variability.

barley enzymes feed processing non-starch polysaccharides

1. Introduction

It is projected that the global demand for eggs and poultry meat will increase in the future, and such a growth will have a profound effect on demand and cost of feed materials. In consequence, the supply of traditional raw materials, especially of energy sources, cannot be met even with optimistic forecasts. The first strategy available to the industry is to expand the feed resource base by evaluating and using alternative energy sources, and barley (*Hordeum vulgare* L.) is one such underexploited cereal. Despite the interest, only one review on barley is available in the literature [1]. Researchers aim to provide a comprehensive discussion of research to date on the feeding value of barley for poultry. It is hoped that this treatise will offer much greater clarity and understanding of the research topic.

2. Classification of Barley

Barley, one of the first domesticated crop, has played a role of multipurpose grain as both food and feed throughout the history. It is extensively cultivated, ranking fourth in world cereal production with an annual production of 157 million metric tonnes [2]. Characteristics such as resistance to drought and saline soils [3] and the ability to mature in climates with short growing seasons [4] have encouraged the cultivation of barley over maize and wheat. In addition to the common usage of barley for malting and brewing (90% of total barley production [5]), it is also used as a feed ingredient in animal diets, especially in Europe where there is the highest concentration of barley cultivation [6][7]. According to records on barley use in animal feeds, 40% of the barley is fed to feedlot cattle, 34% to dairy cows, 20% to pigs and 5% to grazing ruminants, and only less than 1% used for poultry [8].

Morphological and physico-chemical characteristics have laid the foundation for classification of barley. Barley cultivars are classified based on factors such as presence or absence of an awn (a bristle-like appendage), number of the seeds on the stalk, presence or absence of the hull, composition of the starch, aleurone colour and growth height. Moreover, barley is classified according to the growing season as spring or winter cultivars. More genetic selection has been performed on spring barley cultivars, which contain greater energy value [9] and higher resistance to extreme environmental conditions compared to the winter cultivars [10]. The classification of barley based on morphological and physio-chemical characteristics has been comprehensively discussed in Jacob and Pescatore [1].

Classification of barley based on the presence or absence of a hull that contributes to the insoluble fibre fraction [4] is of particular interest to poultry nutritionists. Hull-less or naked barley appears similar to hulled barley until maturity and, then the hulls are loosened and detached during harvesting [11]. In addition to hulled and hull-less barley cultivars, dehulled and pearl barley are produced by the processing of barley grain. Dehulled barley, which is often confused with hull-less barley, is formed by removing the hull from hulled barley. Pearl barley is developed from steam processed and polished (also known as abrading or pearling [12]) dehulled barley. The major difference between dehulled and pearl barley is the presence of both bran and germ in dehulled barley, and absence of bran in pearl barley.

3. Composition

The composition and properties of barley grain are of interest in nutritional studies for their role in determining the availability of nutrients to humans or animals. The large variations in composition, structure and physico-chemical properties in different barley types can provide the basis for the differing responses observed among experiments. Extensive research on the composition of barley has recognised that the wide diversity is mainly associated with the differences in hull and starch type, which will be considered as the basis of comparison.

3.1. Structural Composition

Barley grain is composed of a large endosperm (80% of the cereal grain), an embryo and a mass of maternal tissues. Mature endosperm consists of five types of cells, as aleurone, sub-aleurone, starchy endosperm, embryo-surrounding region, and endosperm transfer cells. Endosperm cells are filled with starch granules embedded in a protein matrix [13] and, therefore, possess a greater nutritional value compared to other parts of barley grain. The embryo is rich in lipids and enzymes while the aleurone layer is rich in soluble protein (about 50%) and is a source of several endogenous enzymes, lipids and vitamins [14]. Endosperm cell walls are thinner than cell walls of other regions in barley grain and, are mainly composed of β-glucans (70%) and smaller amount of arabinoxylans (20% [15]). However, aleurone cell walls are mainly composed of arabinoxylans (67−71%) and smaller amounts of β-glucans (26% [16]).

3.2. Chemical Composition

Wide variability in the chemical composition in different barley cultivars has been reported in the literature [9][17][18], and considerable variation was observed even among similar cultivars [19][20]. Minor changes in chemical composition may result in significant changes in nutrient availability, with remarkable effects on the nutritional quality of barley for poultry [13][21].

Environmental factors such as geographical location [4][10][18][21], year of harvest [4], rainfall [22], soil conditions and fertilisation [23], temperature during grain fill [24][25] and storage conditions [26] can affect the chemical characteristics of barley. Varying effects caused by environmental factors on chemical composition of barley highlight the need to consider the environmental conditions, when comparing the chemical composition of different barley types. Rodehutscord et al. [27] analysed the composition of different cereal grain genotypes grown in the same site, thereby excluding the influence of location, management and fertilisation on nutrient composition. Barley of different genotypes still substantially differed in their chemical composition and physical characteristics.

4. Barley in Poultry Nutrition

Research into barley use in poultry diets has a long history. According to available literature, around 1930s, studies began to emerge comparing barley with other cereal grains for poultry nutrition [28]. The occurrence of wet litter and sticky droppings was first to be noticed as problems associated with feeding barley-based diets. In addition, depressed growth performance and nutrient utilisation of birds fed barley-based diets were observed [10]. Early research acknowledged a close relationship between extract viscosity of barley and growth impairment of birds and the greater digesta viscosity in birds fed barley-based diets was attributed to the NSP present in barley [29][30]. Enzyme preparations were proven to be effective in ameliorating the depressions in growth and nutrient utilisation in birds fed barley-based diets [31][32]. However, the increased interest of the barley usage in poultry feed due to the development of feed enzymes was challenged by the variable responses of birds fed enzyme supplemented barley-based diets [33]. Moreover, the demand for barley as poultry feed has always been inconsistent, presumably driven by changes in economic circumstances [10][34]. In consequence, the choice of other cereals that are less problematic and maybe more economical has restricted the proportion of barley used in poultry diets to less than 1.0% of total barley utilised as animal feed [8]. It is aimed to discuss the impact of barley in broiler diets on growth performance, nutrient utilisation and gut morphometric parameters, with emphasis on strengths and weaknesses of previous studies.

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