Physical properties and functionality of Corn Protein Concentrate in animal feeds

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Physical Properties

Empyreal® 75 (E75), a corn protein concentrate (CPC) is a natural protein golden in color with low levels of ash. Not only does it complement animal proteins in formulation but it also gives the option of lowering the production costs by using fewer grades of animal protein meals, resulting in lower formulation cost. Its high methionine-to-lysine ratio serves as a good source of essential amino acids at a lower cost than other vegetable or animal proteins of comparable purity, consistency and crude protein level. Since animal proteins and other plant ingredients are naturally high in lysine, the addition of CPC will result in a more balanced formulation. Its granular material possess low water solubility but highly soluble in aqueous concentrations of ethanol (Table 1) and it has good oil binding properties.

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Table 1 Corn protein concentrate solubility index (SI).

				Varying Water pH					
Solvent	Deionized water	Water: Ethanol	Ethanol	2	4	5.5	7	9	11
Solubility (%)	2.01	17.70	12.87	0.250	0.150	0.112	1.193	0.612	1.325

Obs: Protein analyses were done on the suspensions using the Bio-Rad Protein Assay. Protein solubility indices were calculated as follows:

SI = [protein content of supernatant / protein content of suspension] x 100

E75 is dried with a flash dryer, which results in a consistent low moisture product with a fine granular appearance (Table 2), with minimal damage to its proteinaceous and vitaminic fractions.

Table 2 Typical particle size distribution

	Retained on US Standard Sieve							
Sieve Size	12	16	20	35	60	80	170	170 throughs
Typical % Overs	0.9	2.6	5.1	13.0	23.6	15.7	26.6	12.3

Functionality

The manufacturing process creates a new ingredient functionality for greater: elasticity, binding and co-mingling with other ingredients, coating, and fat absorption. CPC has superior extrusion functionality over other high protein corn ingredients with finer and more uniform cell structure at comparable extruder setup and specific mechanical energy (SME). Better incorporation and intermixing with other ingredients leads to less fines loss due to non-incorporated particles.

The following examples show, in dog and cat food, the dough-like properties of the extrudate provides a smoother kibble surface both on the die and knife surfaces (Figures 1 and 3). The extrusion properties of CPC provide a new tool to control expansion with an economical source of protein and lessen the reliance on starch for structure and expansion properties (Figure 2), also requiring less steam during the process.

Shelf life

CPC is rich in nutrients and possesses a high concentration of natural antioxidants. This benefits the overall health of the animal, while also extending the product's shelf life which should be shelf-stable for up to twelve months.

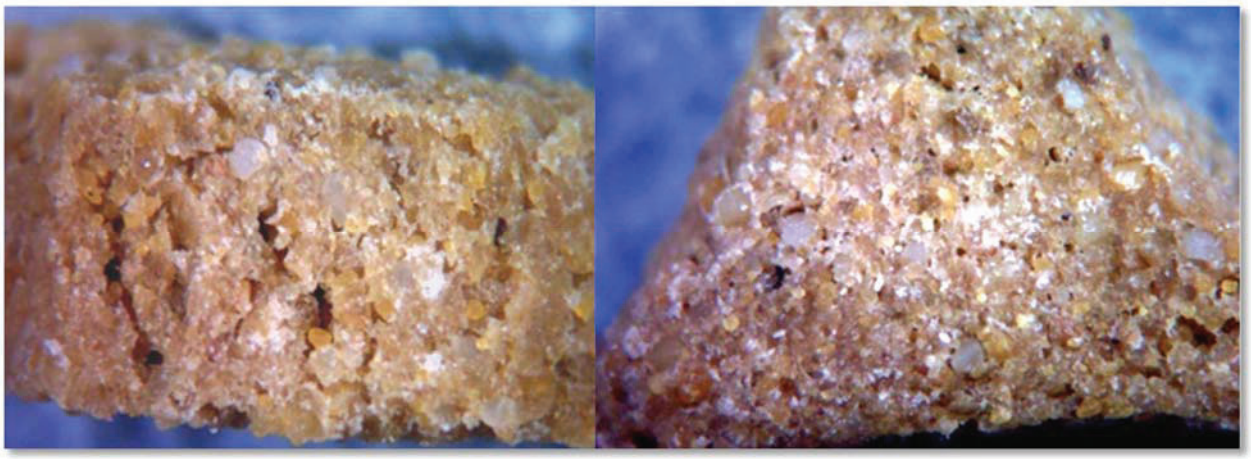

Figure 1: internal cross section of cat kibble with CGM included (left), kibble surface of cat kibble with CPC included (right). 15x magnification.

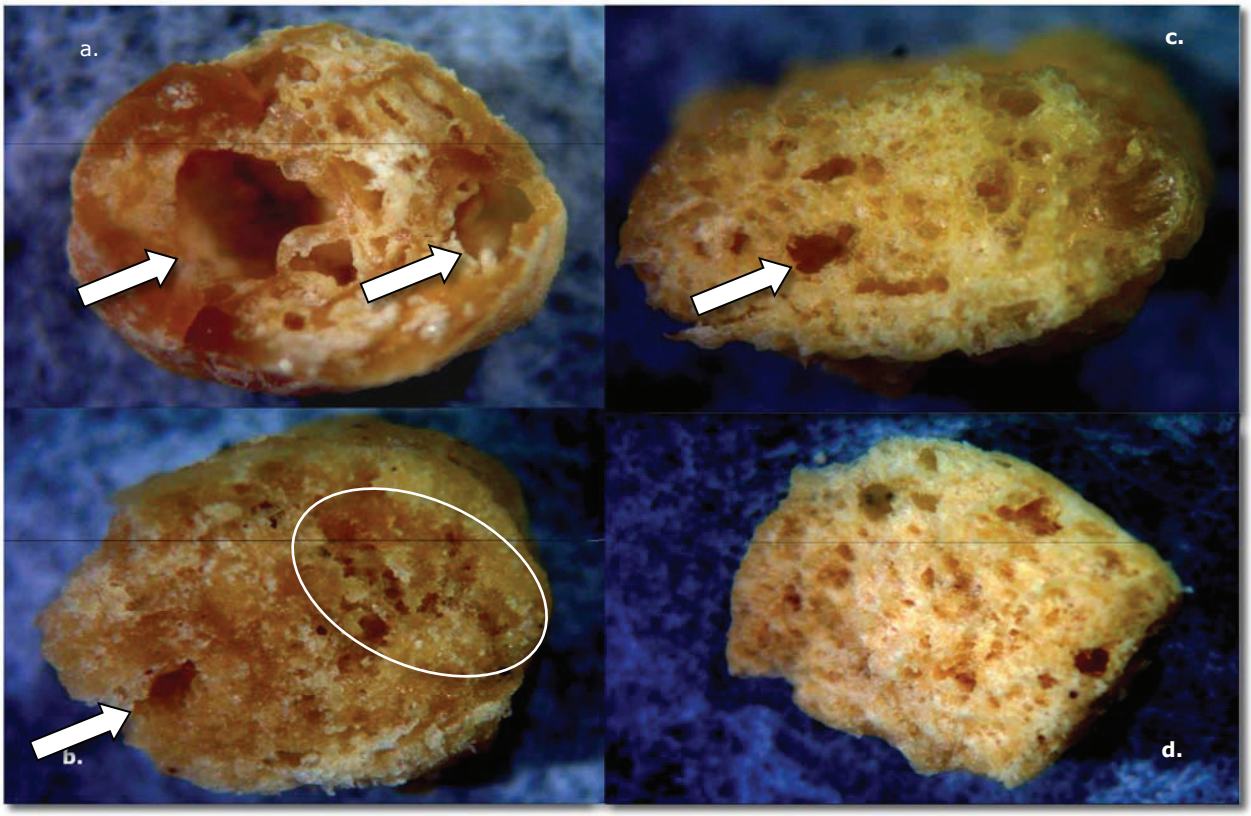

Figure 2: Internal matrix of extruded samples of CGM (a.), CGM plus 15% fat (b.), CPC (c.), and CPC plus 15% fat (d.). Twin extrusion system used. 15x magnification.

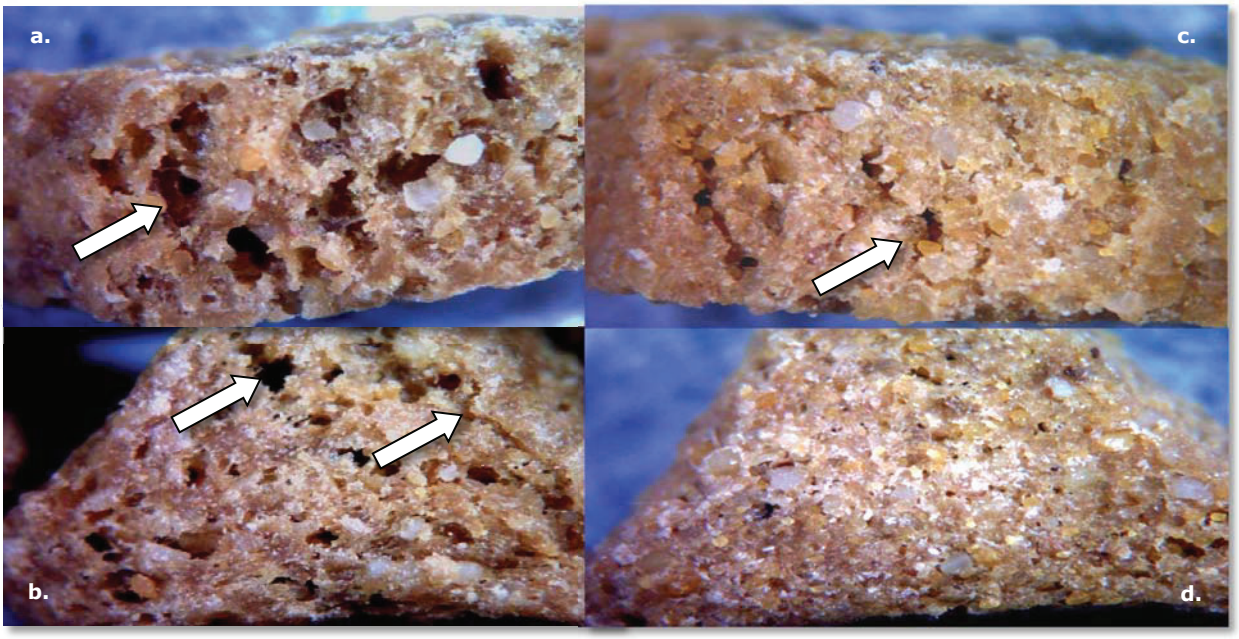

Figure 3:Physical appearance of cat kibbles. Internal matrix of fractured (a.) and knife surface (b.) with CGM or CPC, fractured (c.) and knife surface (d.). 15x magnification.

Water Absorption and Solubility Indexes

Water absorption index (WAI) and water solubility index was determined as outlined in American Association of Cereal Chemists (AACC) Official Methods and calculated as:

%WAI = net weight of wetted sample/original weight sample (dry basis) x 100

Water solubility index (WSI) was calculated as the percent solids of the original material (db) present in the supernatant. Additionally, the % solubilized protein was calculated as the calculated percent of the original samples protein content that was measured in the supernatant after centrifuging as measured by CRA Official Method G-66 and a protein conversion factor of 6.25.

Oil Binding and Adsorption Index

The oil binding index (OBI) and oil adsorption indexes (OAI) were calculated as follows:

- Oil Binding Index = weight of oil lost/weight of material (db)*100.
- Oil Adsorption Index = Weight increase of pellet (db)/weight of protein material (db) *100.
- Increase of dry basis weight of the protein material was assumed to be oil adsorbed during treatment.

Table 3 – Water absorption index (WAI), water solubility index (WSI) and percentage of solubilized protein of Empyreal 75.

WAI (%)	WSI (%)	% Solubilized Protein
280	5.5	4.2

Water absorption index and water solubility index of CPC was also determined in either deionized water (DI H2O) or in 0.5% sodium chloride (NaCl) solution and incubated at 22, 50, or 99°C for 1hr.

Table 4 – Water absorption index (WAI) and percent of solubilized protein under different temperatures (22, 50 or 99°C) with different solvents, deionized water (DI H2O) or 0.5% sodium chloride (NaCl) solution.

Temperature (°C)	Solvent	WAI (%)	% Solubilized Protein
22	DI H2O	228	3.6
22	NaCl	227	3.5
50	DI H2O	211	3.5
50	NaCl	219	3.6
99	DI H2O	210	4.2
99	NaCl	209	4.4

Table 5 – Percentage of corn oil bound (OBI) and adsorbed (OAI) by the CPC.	
OBI (%)	OAI (%)
236	103

The physical attributes of CPC allow good extrusion or other mechanical processing characteristics with minimal water requirements for functionality with, also, increased water stability of the finalized diet, an essential requirement of any aquaculture feed. Its high oil binding and adsorption indexes make it a very desirable ingredient for any diet in which high amounts of fat are required (e.g. marine species).

The cost-benefit of this alternative protein source during manufacturing, as well as the increase in pellet quality, gives the manufacturer and the final consumer total satisfaction with economical savings.

More information

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