Protein Quality of Cooked Pulses (PDCAAS Method)

Pulses (peas, lentils, beans and chickpeas) are high protein foods. The protein content of pulses typically ranges from 21 to 26%. For food labeling purposes, protein content claims are based not only on quantity but also on quality, or nutritional value, of the protein in the food product. In 2011, *in vivo* studies were conducted to assess the protein digestibility of nine Canadian pulse types to understand the quality of these plant-based sources of protein.

1 Pulses and Protein Quality

The nutritional value of high protein foods are based on both protein quantity and quality. A recent study assessed the protein quality of cooked pulses using the Protein Digestibility Corrected Amino Acid Score (PDCAAS) method. PDCAAS values for pulses are shown in Figure 1 and are compared with casein (House et al., 2011, unpublished data). Existing PDCAAS values for processed pulses (autoclaved) obtained from the report of the Joint FAO/WHO Expert Consultation (1989) are also presented where the data is available. The PDCAAS is a product of the amino acid score and the percent true protein digestibility which are shown for each pulse type in Table 1.

In the current study, navy beans, whole green lentils and yellow split peas showed the highest PDCAAS values (0.63 to 0.67), while the other beans (black, kidney and pinto), chickpeas, split green peas and red lentils scored between 0.50 to 0.59. The new PDCAAS values are similar to those in the 1989 WHO/FAO report on protein quality (Figure 1).

As the protein quality of foods is dictated by their limiting amino acid, the resulting PDCAAS values for most pulses alone may not achieve a protein claim under the current US Food Labeling Regulations. However, combining pulses with other plant-based protein sources such as cereal grains can generate a more complete protein.

Figure 1: Existing versus new PDCAAS values for pulses.

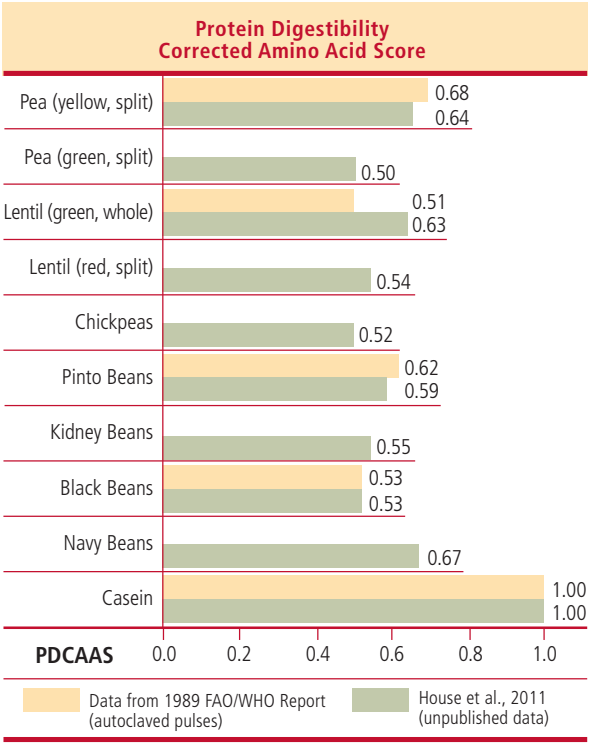

Table 1: PDCAAS values for pulses and select cereal grains.

Table 1	Amino Acid Score[1]	True Protein Digestibility[2] (%)	PDCAAS[3]
Pea (yellow, split)	0.73	87.9	**0.64**
Pea (green, split)	0.59	85.2	**0.50**
Lentil (green, whole)	0.71	87.9	**0.63**
Lentil (red, split)	0.59	90.6	**0.54**
Chickpeas	0.61	85.0	**0.52**
Pinto Beans	0.77	76.2	**0.59**
Kidney Beans	0.70	78.6	**0.55**
Black Beans	0.76	70.0	**0.53**
Navy Beans	0.83	80.0	**0.67**
Soy Flour	0.92	83.5	**0.77**
Wheat Flour*	0.47	92.3	**0.43**
Rice Flour*	0.54	92.0	**0.50**
Lentil-Wheat (25:75) Blend*	0.78	91.0	**0.71**
Lentil-Rice (20:80) Blend*	0.82	90.0	**0.74**
Black Bean-Rice (25:75) Blend*	0.81	93.0	**0.75**
Pea-Wheat (30:70) Blend*	0.83	90.0	**0.75**
Casein	1.04	96.6	**1.00**

[1] Amino acid score is limiting the amino acid with the lowest ratio relative to the established amino acid requirement values for humans, aged 2 to 5 years old.

[2] AOAC Method 991.29 (n = 10).

[3] PDCAAS = Amino Acid Score x % True Protein Digestibility.

* Calculated data obtained from the 1989 WHO/FAO Report on Protein Quality.

2 Complementary Proteins

Products containing a combination of plant protein sources can have improved protein quality due to their complementary amino acid profiles. For example, the protein in pulses is higher in lysine and lower in sulphur amino acids, while cereal grains such as wheat or rice are lower in lysine and higher in sulphur amino acids. The synergistic association of these amino acids from these various plant sources is demonstrated in the case of blending pulses with wheat or rice (Table 1). The optimal addition of lentil, black bean or pea to either wheat or rice increases the overall PDCAAS values ranging from 0.43 and 0.64 in the individual pulse or cereal to 0.71 and 0.75 in the blends. The improved protein quality of combined pulses and cereals can have nutritional advantages when using these blends for formulating food products.

Foods containing a combination of plant protein sources can have improved protein quality due to their complementary amino acid profiles.

Pulse Canada

1212-220 Portage Avenue
Winnipeg, Manitoba,
Canada R3C 0A5
Telephone: 204.925.4455
Fax: 204.925.4454
Email: office@pulsecanada.com
www.pulsecanada.com

3 Making Protein Content Claims on Foods

Companies marketing foods in the USA can use PDCAAS values to make protein quality claims. Protein content claims in the USA are based on a calculation that accounts for the amount of protein in a reference amount of food product, the PDCAAS value and the daily value (DV) for protein which is set at 50 grams.

$$\%DRV = \frac{\text{Protein in reference food amount (grams)} \times \text{PDCAAS}}{\text{Daily Value for Protein (grams)}}$$

% DRV 10.0 to 19.9% "Good Source of Protein"

% DRV >20.0% "Excellent Source of Protein"

Protein claims on multi-ingredient foods can also be calculated using PDCAAS values obtained from a weighted average procedure. For example, the PDCAAS for pasta made with a 25:75 blend of lentil and durum wheat flour is shown in Table 2. The weighted PDCAAS for the reformulated pasta containing a complementary blend of lentil and durum wheat flour has a higher score (0.71) than the regular pasta containing 100% durum wheat (0.43). Based on both the protein quality and quantity in the pasta, the addition of 25% lentil flour improves the balance of their essential amino acids, thereby qualifying this reformulated product as a **"Good Source of Protein"**. Reformulating cereal-based foods with pulse ingredients has the potential to increase the protein quality of the overall food product.

Table 2: Sample calculations* for the protein quality of traditional wheat-based pasta versus wheat pasta incorporated with 25% lentil flour.

Table 2	Traditional Pasta 100% DURUM Wheat Flour	Reformulated Pasta 25:75 Lentil/Durum Wheat Flour Blend
Protein Content of Pasta (%)	11.7	**14.7**
PDCAAS of Pasta	0.43	**0.71**
Reference Amount for Pasta (g)	55	55
Protein per Reference Amount (g)	6.4	**8.1**
Daily Value for Protein (g)	50	50
% DRV	5.6	**11.5**
Protein Claim Permitted	N/A	**Good Source of Protein**

*Calculation based on the 1989 WHO/FAO Report on Protein Quality.

4 Pulses Can Reduce the Environmental Footprint of Your Grocery Cart

Pulses and other legumes are plants that are uniquely able to use atmospheric nitrogen as a source of plant nutrients. This greatly reduces the amount of non-renewable energy that is needed to provide the crop with their essential nutrients. Growing pulses releases as little as 1/3 of the greenhouse gases of other crops, and lowers the carbon footprint of other crops grown in rotation*. Reformulating pasta and other cereal-based products with pulse ingredients has the potential to decrease the carbon footprint of the overall food product.

*Gan, Y., Liang, C., Wang, X., and McConkey, B., 2011. Lowering carbon footprint of durum wheat by diversifying cropping systems. *Field Crops Research*, 122, 199-206.

Reformulating cereal-based foods with pulse ingredients has the potential to increase the protein quality of the overall food product.

Growing pulses releases as little as 1/3 of the greenhouse gases of other crops.

healthy people healthy planet

Canada

This material has been made possible through Agriculture and Agri-Food Canada's Agricultural Flexibility fund, as part of Canada's Economic Action Plan.