HOKU NUI MAUI

AQUATIC RESOURCES FOR CHICKEN FEED

OPTIMAL NUTRITION

Roth Ecological Design Intl. (REDI) evaluated various types of plants that could be grown in or along the berms of the ponds at Hoku Nui Maui (HNM). Importantly, some of the proposed species identified have been known to have invasive characteristics, and should these plants be chosen to cultivate inside the ponds, proper management techniques will need to be identified to insure that these plants stay contained within the ponds. This report summarizes the findings and compares the nutritional qualities of known plants that may have beneficial use as supplemental chicken feed for the egg laying hens at HNM. There are many differing requirements published as to the nutrition requirements of laying hens. In an effort to collate and compare recommended daily allowances (RDA) with HNM's feed options, the tables below contain internationally recognized guidelines to compare with feed options for HNM hens. Important to note is that the minimum dietary requirements are insufficient to promote optimal egg production, the health of laying hens, nor general welfare of the poultry (Coutes & Wilson, 2007).

Excerpted from the Merck Veterinary Manual on the Nutritional Requirements of Poultry, Table 1 below lists the specific requirements of hens kept for the egg laying capacity, which have requirements above those of free-range hens or other feral birds.

Table 1: Nutritional Requirements of Laying Hens – Different Feed Intake Levels

Nutrient Requirements of Laying Hens at Different Feed Intakes [a]					
Pounds (approx.)/100 birds/day	**18**	**20**	**22**	**24**	**26**
Grams of feed/bird/day	**80**	**90**	**100**	**110**	**120**
White-Egg Layers					
Protein	18.8	16.7	15.0	13.6	12.5
Arginine	0.88	0.78	0.70	0.64	0.58
Lysine	0.86	0.77	0.69	0.63	0.58
Methionine	0.38	0.33	0.30	0.27	0.25
Methionine + cystine	0.73	0.64	0.58	0.53	0.48
Threonine	0.59	0.52	0.47	0.43	0.39
Tryptophan	0.20	0.18	0.16	0.15	0.13
Calcium	4.12	3.67	3.30	3.00	2.75
Phosphorus, available	0.31	0.28	0.25	0.23	0.21
Brown-Egg Layers					
Protein	22.5	20.0	18.0	16.4	15.0
Arginine	1.06	0.94	0.85	0.77	0.71
Lysine	1.05	0.93	0.84	0.76	0.70
Methionine	0.45	0.40	0.36	0.33	0.30
Methionine + cystine	0.89	0.79	0.71	0.65	0.59
Threonine	0.71	0.63	0.57	0.52	0.48
Tryptophan	0.24	0.21	0.19	0.17	0.16
Calcium	5.00	4.44	4.00	3.64	3.33
Phosphorus, available	0.38	0.33	0.30	0.27	0.25

[a] Requirements are listed as percentages of diet.

Source: Klassing, 2015

Comparing this to the feed currently being given to the HNM chickens from Modesto Millin Organic Chicken Starter, the current feed is deficient in: Arginine, Methionine + cysteine, Threonine, and Tryptophan. Arginine deficiency can manifest as a cupped feather structure in hens where generalized amino acid deficiency can reduce egg size, egg production and retard growth of the hens (Klassing, 2015).

Table 2: Hoku Nui Maui's Current Feed Compared to RDA Recommendations

Component		Organic Chick Starter	Layer Feed	RDA
Crude Protein	*Min*	22.0%	17%	12.5 – 22.5%
Lysine	*Min*	1.0%	0.81%	0.58 – 1.05%
*Arginine	-	-	-	0.58 – 1.06%
Methionine	*Min*	0.4%	0.31%	0.25 – 0.45%
*Methionine + cysteine	-	-	-	0.48 – 0.89%
*Threonine	-	-	-	0.39 - 0.71%
*Tryptophan	-	-	-	0.13 – 0.24%
Crude Fat	*Min*	3.6%	2.6%	-
Crude Fiber	*Max*	4.5%	4.5%	-
Ash	*Max*	8.7%	15.5%	-
Calcium	*Range*	0.8 - 1.2%	3.2 – 4.5%	2.75 – 5%
Phosphorus	*Min*	0.46%	0.38%	0.21 – 0.38%
Salt	*Range*	0.37 – 0.52%	0.37 – 0.52%	-
Sodium	*Max*	0.21%	0.35%	-

(-) Indicates that the source was not accounted for; * Indicates potential deficiencies

(Source data: Klassing, 2015; Modesto Milling)

It is unknown whether vitamin supplementation is being provided to the hens at HNM. Table 3 below outlines optimal supplementation levels. According to the Merck Veterinary Manual for Poultry, a seminal source of information regarding the health issues of poultry, Calcium and phosphorus deficiency can result in abnormal bone and shell development. Insufficient levels of D3 can lead to Rickets where low manganese levels can lead to thin shelled eggs and stunted leg and wing elongation. Iron and copper are important to protect against anemia, loss of bone density or feather coloration. Iodine is necessary to maintain proper thyroid function. Magnesium deficiencies can cause a rapid decline in egg production where potassium and sodium are essential for electrolyte balance. Nervousness and excessive stress response can be attributed to low levels of chloride. Selenium is essential for the metabolism of vitamin E – low levels of both can lead to the ruffling of feathers, tissue bruising or damage and scabbing on the skin. Zinc deficiencies can retard or distort growth (Klassing, 2015).

Table 3: Optimal Vitamin Supplementation Levels

Vitamins (added to air-dried feed)	Replacement Pullets	Laying Hens
Vitamin A (IU/kg)	7 000 – 10 000	8 000 – 12 000
Vitamin D3 (IU/kg)	1 500 – 2 500	2 500 – 3 5001
Vitamin E (mg/kg)	20 – 30	15 – 302
Vitamin K3 (mg/kg)	1 – 3	2 – 3
Vitamin B1 (mg/kg)	1.0 – 2.5	1.0 – 2.5
Vitamin B2 (mg/kg)	4 – 7	4 – 7
Vitamin B6 (mg/kg)	2.5 – 5.0	3.0 – 5.0
Vitamin B12 (mg/kg)	0.015 – 0.025	0.015 – 0.025
Niacin (mg/kg)	25 – 40	20 – 50
Pantothenic acid (mg/kg)	9 – 11	8 – 10
Folic acid (mg/kg)	0.8 – 1.2	0.5 – 1.0
Biotin (mg/kg)	0.10 – 0.15	0.10 – 0.15
Vitamin C (mg/kg)	100 – 150	100 – 200
Hy•D® (25-OH D3) (mg/kg)	0.0693	0.0693
Choline (mg/kg)	200 – 400	300 – 500

[1] Do not exceed 3000 IU D3/kg feed when using Hy•D®
[2] Under heat stress conditions: 200 mg/kg [3] Local legal limits of total dietary vitamin D activity need to be observed

Source: DSM Vitamin Supplementation Guidelines, 2006; Optima Nutrición Vitamínica de los animales para la producción de alimentos de calidad, 2002

Source: Coutes & Wilson, 2007)

AQUATIC PLANTS

There are several species of aquatic plant suitable for animal feed, namely: Azolla, Dal grass; Duckweed; Microalgae; Salvinia; Seaweeds; Water hyacinth; and Water spinach. Of the preceding plants, the following which are detailed below are suitable for poultry. Supplementation of the dry feed with aquatic plants has the potential not only to reduce the amount of feed purchased but also to provide vital amino acids, vitamins and minerals to the hens promoting optimal wellbeing of the birds and increased production and quality of the eggs they produce.

FRESHWATER SPECIES

AZOLLA

Commonly refereed to as fairy moss, mosquito fern and duckweed fern, the Azolla genus contains 5 to 7 species in both the Azollaceae and Salviniaceae families. Common in warm temperate and tropical regions, Azolla is a short-branched aquatic fern with a floating stem. It forms a dense mat on the water's surface thus its propagation must be controlled in areas where it has the potential to impede

flow. Depending on its anthocyanin content (light adaptive pigment) it ranges from green to reddish-brown. Azolla has a long history of use for nitrogen fixation (atmospheric), weed and mosquito suppression (CIRAD, AFZ and FAO, 2016).

As animal feed, it is highly productive, doubling its biomass every 3 to 10 days, with substantial protein content (19- 30%) (Tran, 2015). Suitable for a number of different animals, Azolla, in spite of its nutritive profile, is recommended to comprise no more than 15% of the diet for laying hens (Alalade et al., 2007; Khatun et al., 2008).

Table 4: Nutritive Components Azolla - fresh (various species)

Main analysis	**Unit**	**Avg**
Dry matter	% as fed	91.9
Crude protein	% DM	21.5
Crude fiber	% DM	16.1
NDF	% DM	49.5
ADF	% DM	40.4
Lignin	% DM	8.9
Ether extract	% DM	3.3
Ash	% DM	19.2
Gross energy	MJ/kg DM	16.4
Minerals	**Unit**	**Avg**
Calcium	g/kg DM	12.5
Phosphorus	g/kg DM	6.7
Potassium	g/kg DM	12.5
Sodium	g/kg DM	0.0
Magnesium	g/kg DM	3.5
Manganese	mg/kg DM	174
Zinc	mg/kg DM	88
Copper	mg/kg DM	17
Iron	mg/kg DM	756
Amino acids	**Unit**	**Avg**
Alanine	% protein	5.8
Arginine	% protein	6.4
Aspartic acid	% protein	8.3
Cystine	% protein	0.9
Glutamic acid	% protein	9.6
Glycine	% protein	4.9
Histidine	% protein	1.6
Isoleucine	% protein	3.9
Leucine	% protein	8.7
Lysine	% protein	5.6
Methionine	% protein	1.5
Phenylalanine	% protein	4.7
Proline	% protein	4.0
Serine	% protein	4.1
Threonine	% protein	4.3
Tryptophan	% protein	1.2
Tyrosine	% protein	3.1
Valine	% protein	4.5

DM = Dry Matter; Source: Heuzé V., Tran G., 2015.

DUCKWEED

In the *Lemnacae* or *Aracaea* families, there are four primary species of duckweed in fiver genera: *Lemna minor* common duckweed; *Lemna gibba* bloated or inflated; *Spirodela polyrhiza* greater duckweed or water flax*;* and *Wolffia arrhiza* which is rootless (Heuzé and Tran, 2015). Generally, they are small vascular plants, which are free-floating and without stems.

Consumed by both wild and domesticated fowl, duckweeds adapt to a wide variety of climactic conditions and are easily established, robust plants. Their high yield and potential invasive capacity requires managed growth. Due to its capacity to bioaccumulate, duckweeds intended for feed should not be raised in water laden with heavy metals, organic pathogens or other toxins. It is also considered be highly invasive and managing it in a closed system is recommended. The nutritive content of this metabolically active, non-structural plant is dependent upon its growth medium. As such its protein content ranges from 7 to 45% - in optimal conditions is protein content is between 30 and 40% (Hasan et al., 2009). Studies conducted in the United States, Peru and Vietnam have shown promising results substituting duckweed for broken rice and soy with 12.6 to 100% duckweed (Anderson et al., 2011; Haustein et al., 1998; Nguyen Thi Kim Kang et al., 2004).

Table 5: Nutritive Components Duckweed - fresh (various species)

Main analysis	Unit	Avg
Dry matter	% as fed	5.6
Crude protein	% DM	29.1
Crude fiber	% DM	12.5
NDF	% DM	40.1
ADF	% DM	18.5
Lignin	% DM	5.7
Ether extract	% DM	6.1
Ash	% DM	15.9
Gross energy	MJ/kg DM	18.2
Minerals	**Unit**	**Avg**
Calcium	g/kg DM	23.3
Phosphorus	g/kg DM	5.7
Potassium	g/kg DM	42.9
Sodium	g/kg DM	1.4
Manganese	mg/kg DM	1723
Zinc	mg/kg DM	75
Copper	mg/kg DM	20
Iron	mg/kg DM	0
Amino acids	**Unit**	**Avg**
Alanine	% protein	4.3
Arginine	% protein	4.4
Aspartic acid	% protein	6.8
Glutamic acid	% protein	7.1
Glycine	% protein	3.6
Histidine	% protein	1.7
Isoleucine	% protein	3.6
Leucine	% protein	6.6
Lysine	% protein	3.9
Methionine	% protein	0.8
Phenylalanine	% protein	4.1
Proline	% protein	2.9
Serine	% protein	2.6
Threonine	% protein	3.1
Tyrosine	% protein	2.7
Valine	% protein	4.3

DM = Dry Matter; (*) indicates that the average value was obtained by an equation.

Source: Heuzé V., Tran G., 2015.

MICROALGAE

Most notable of the microalgae is Spirulina, a member of the *Arthrospira* genus, containing both *Spirulina maxima* and *Spirulina platensis*. Unicellular and filamentous they are both photosynthetic and autotrophic (capable of self-nourishment). Suitable as a feed supplement, Spirulina is known to improve the color and viscosity of the yolk in laying hens and reduce the mortality of growing chicks due to the presence of Astaxanthin (Heuzé, Tran and Lebas, 2016).

Table 6: Nutritive Components Microalgae – dried

Main analysis	Unit	Avg
Dry matter	% as fed	92.3
Crude protein	% DM	63.8
Crude fiber	% DM	2.9
NDF	% DM	0.1
ADF	% DM	0.0
Ether extract	% DM	6.1
Ash	% DM	8.9
Insoluble ash	% DM	0.1
Gross energy	MJ/kg DM	21.3
Minerals	**Unit**	**Avg**
Calcium	g/kg DM	0.8
Phosphorus	g/kg DM	6.6
Sodium	g/kg DM	7.0
Chlorine	g/kg DM	1.4
Iron	mg/kg DM	560
Amino acids	**Unit**	**Avg**
Alanine	% protein	7.0
Arginine	% protein	4.6
Aspartic acid	% protein	9.2
Cystine	% protein	0.9
Glutamic acid	% protein	13.7
Glycine	% protein	4.8
Histidine	% protein	3.7
Isoleucine	% protein	5.8
Leucine	% protein	8.5
Lysine	% protein	4.4
Methionine	% protein	2.2
Phenylalanine	% protein	4.3
Proline	% protein	3.6
Serine	% protein	4.9
Threonine	% protein	4.8
Tryptophan	% protein	1.4
Tyrosine	% protein	4.4
Valine	% protein	6.4

DM = Dry Matter; (*) indicates that the average value was obtained by an equation.

(Source: Feedipedia)

SALVINIA

Salvinia molesta, is an aquatic fern. Free-floating, it is highly productive, it can double its biomass in three days and has the potential to be invasive if not carefully managed (Moozhiyil et al., 1989; CABI, 2016). Due to its invasive qualities, managing this species in a closed system is recommended. It is very efficient at removing nutrients from water.

Table 7: Nutritive Components Salvinia - fresh

Main analysis	Unit	Avg
Dry matter	% as fed	7.7
Crude protein	% DM	12.4
Crude fiber	% DM	35.5
Ether extract	% DM	2.8
Ash	% DM	17.1
Gross energy	MJ/kg DM	16.9
Amino acids	**Unit**	**Avg**
Arginine	% protein	4.7
Cystine	% protein	1.8
Glycine	% protein	5.8
Histidine	% protein	1.7
Isoleucine	% protein	3.6
Leucine	% protein	7.5
Lysine	% protein	3.7
Methionine	% protein	1.4
Phenylalanine	% protein	5.0
Threonine	% protein	4.8
Tryptophan	% protein	1.1
Tyrosine	% protein	3.5
Valine	% protein	5.3

The asterisk * indicates that the average value was obtained by an equation.

References

Moozhiyil et al., 1989

WATER HYACINTH

Eichhornia crassipes, is a fresh water species of perennial herb growing in rhizome dense mats. Exceptional in its productivity, it has the potential to be highly invasive and thus must be carefully monitored and controlled. As animal feed, the aerial plant parts are chopped and fed directly though with poultry, direct feeding may be not only possible but also preferable (Heuzé et al., 2015). Due to its high water content, it has not previously been suggested as a high percentage inclusion to the diets of laying hens. As with many aquatic plants, the nutritive quality is dependent upon the water in which it is grown.

Table 8: Nutritive Components, Water Hyacinth - aerial parts, fresh

Main analysis	Unit	Avg
Dry matter	% as fed	8.1
Crude protein	% DM	13.5
Crude fiber	% DM	20.2
NDF	% DM	64.7
ADF	% DM	33.8
Lignin	% DM	9.3
Ether extract	% DM	2.8
Ash	% DM	18.7
Gross energy	MJ/kg DM	16.2
Minerals	Unit	Avg
Calcium	g/kg DM	11.3
Phosphorus	g/kg DM	3.0
Potassium	g/kg DM	25.3
Sodium	g/kg DM	2.0
Magnesium	g/kg DM	5.0
Manganese	mg/kg DM	679
Zinc	mg/kg DM	52
Copper	mg/kg DM	12
Iron	mg/kg DM	523
Amino acids	Unit	Avg
Arginine	% protein	6.7
Glutamic acid	% protein	8.8
Glycine	% protein	5.2
Histidine	% protein	1.7
Isoleucine	% protein	5.1
Leucine	% protein	8.4
Lysine	% protein	4.3
Methionine	% protein	1.3
Phenylalanine	% protein	5.2
Threonine	% protein	3.9
Valine	% protein	5.6

DM = Dry Matter; (*) indicates that the average value was obtained by an equation.
Source: Feedipedia

WATER SPINACH

*Ipomoea aquatic, al*so called swamp cabbage, water spinach is a plant favoring marsh for growth, which has water-filled hollow stems and funnel shaped flowers. It is a member of the Convolvulaceae family (morning glory). It has arrow shaped leaves, pink tinted flowers and may crawl or growth erect depending on the water depth (World Crops, 2016).

A study conducted in Vietnam evaluated the inclusion of water spinach (as well as duckweed) as a supplement to a grain based diet for hens. Thi Thuy and Ogle (2004) reported an improvement in skin and yolk color as well as a lessened fat content of the hens after the experiment with the green feed.

Important to note is that duckweed showed a marked advantage over water spinach as it required no further processing (i.e. chopping) after removal and prior to feeding.

Table 9: Nutritive Components, Water Spinach

Main analysis	Unit	Avg
Dry matter	% as fed	9.2
Crude protein	% DM	34.3
Crude fiber	% DM	10.2
Ether extract	% DM	3.9
Ash	% DM	12.9
Gross energy	MJ/kg DM	18.3
Main analysis	Unit	Avg
Dry matter	% as fed	9.2
Crude protein	% DM	34.3
Crude fiber	% DM	10.2
Ether extract	% DM	3.9
Ash	% DM	12.9
Gross energy	MJ/kg DM	18.3

The asterisk * indicates that the average value was obtained by an equation.
Source: Thi Thuy & Ogle, 2004

WATERCRESS

Watercress, or *Nasturtium Officinale,* is a non-invasive aquatic plant suitable for chicken feed. Aquatic and semi-aquatic, it is a perennial herb with succulent hollow stems (USGS, 2014). Watercress could be grown on floating racks within the HNM pond(s).

Table 10: Nutritive Components, Watercress - fresh

Main analysis	Unit	Avg
Crude protein	% DM	0.23
Gross energy	Kcal	11
Minerals	Unit	Avg
Calcium	g/kg DM	12
Phosphorus	g/kg DM	9
Potassium	g/kg DM	7
Sodium	g/kg DM	3
Magnesium	g/kg DM	6
Iron	mg/kg DM	2

Source: USDA, 2016

PICKLEWEED

Commonly known as Pickleweed or Glasswort elsewhere, in Hawaii it is referred to as sea asparagus, the *Salicornia* genus is in the Amaranthaceae (Ball, 2004). Growing erect in marshy areas, it could be a suitable species to introduce to the banks of a constructed wetland. It is also an effective at phyto-remediating selenium through the processes of phytoextraction and volitization (Eichorn, Rave & Evert, 2011). This plant prefers brackish water, but has been grown in freshwater wetlands as well.

Table 11: Nutritive Components, Pickleweed

Main analysis	**Unit**	
Crude protein	% DM	1.54
Crude fiber	% DM	0.83
Gross energy	kcal	4.48
Minerals	**Unit**	
Calcium	mg/g	0.62
Phosphorus	mg/g	9.18
Copper	mg/g	0.91
Cadmium	mg/g	0.01
Chromium	mg/g	<0.01
Lead	mg/g	0.02
Potassium	mg/g	1.76
Sodium	mg/g	9.98
Magnesium	mg/g	1.18
Zinc	mg/g	4.05
Iron	mg/g	0.01
Amino acids	**Unit**	
Arginine	g/kg	1.16
Glutamic acid	g/kg	1.63
Glycine	g/kg	0.53
Histidine	g/kg	0.26
Isoleucine	g/kg	0.47
Leucine	g/kg	0.94
Lysine	g/kg	0.73
Methionine	g/kg	0.55
Phenylalanine	g/kg	0.55
Threonine	g/kg	0.55
Serene	g/kg	0.68
Alanine	g/kg	0.69
Tyrosine	g/kg	0.44
Cysteine	g/kg	0.03
Valine	g/kg	0.59
Proline	g/kg	0.83

Source: Lu et al., 2009

AKULIKULI

Sesuvium portulacastrum, sea purslane, *akulikuli* – all refer to the native Hawaiian succulent groundcover. This plant prefers brackish water, but has been grown in freshwater wetlands as well.

Table 12: Nutritive Components, Akulikuli - seed

Main Analysis	Unit	
Gross energy	%	46.5
Fructose	%	0.1
Glucose	%	0.03
Sucrose	%	1.20
Fat	%	25
Protein	%	17.3
Calcium	%	0.16
Iron	%	0.03
Magnesium	%	0.42
Phosphorus	%	0.84
Potassium	%	0.85
Sodium	%	0.05

Source: Massimo, 2003

Table 13: Comparison between aquatic plants and HNM feed and RDA

Component		HNM Chick Starter	HNM Layer Feed	RDA	Azolla	Duckweed	Microalgae	Salvinia	Water Hyacinth	Water Spinach	Watercress
		% DM	**% DM**	***% range***	***avg %***	***avg %***	***avg %***	***avg %***	***avg %***	***avg %***	***avg %***
Crude Protein	Min	0.22	0.17	12.5 – 22.0	21.5	29.1	63.8	12.4	13.5	34.3	0.23
Lysine	Min	0.01	0.0081	0.58 – 1.05	5.6	6.6	4.4	3.7	4.3	-	
Arginine	-	-	-	0.58 – 1.06	6.4	4.4	4.6	4.7	6.7	-	
Methionine	Min	0.004	0.0031	0.25 – 0.45	1.5	3.9	2.2	1.4	1.3	-	
Methionine + cysteine	-	-	-	0.48 – 0.89	0.9	-	0.9	1.8	-	-	
Threonine	-	-	-	0.39 - 0.71	4.3	2.6	4.8	4.8	-	-	
Tryptophan	-	-	-	0.13 – 0.24	1.2	3.1	1.4	1.1	-	-	
Crude Fat	Min	0.036	0.026	-	-	-	-	-	-	-	0.001
Crude Fiber	Max	0.045	0.045	-	16.1	12.5	2.9	35.5	20.2	10.2	
Ash	Max	0.087	0.155	-	19.2	15.9	8.9	17.1	28.7	12.9	
Calcium	Range	0.8 - 1.2	3.2 – 4.5	2.75 – 5	12.5	23.3	0.8	-	11.3	-	12
Phosphorus	Min	0.0046	0.0038	0.21 – 0.38	6.7	5.7	6.6	-	3	-	9
Salt	Range	0.37–0.52	0.37–0.52	-	-	-	-	-	-	-	-
Sodium	Max	0.0021	0.0035	-	0	1.4	7	-	2	-	3
Additional Components											
Dry matter		-	-	-	91.9	5.6	92.3	7.7	8.1	9.2	-
NDF		-	-	-	49.5	40.1	0.1	-	64.7	-	-
ADF		-	-	-	40.4	18.5	0	-	33.8	-	-
Lignin		-	-	-	8.9	5.7	-	-	9.3	-	-
Ether extract		-	-	-	3.3	6.1	6.1	2.8	2.8	3.9	-
Gross energy	MJ/kg	-	-	-	16.4	18.2	21.3	16.9	16.2	18.3	11
Minerals											
Potassium	g/kg	-	-	-	12.5	42.9	-	-	3	-	7
Magnesium	g/kg	-	-	-	3.5	1.4	-	-	5	-	6
Manganese	g/kg	-	-	-	174	1723	-	-	679	-	12
Zinc	g/kg	-	-	-	88	75	-	-	52	-	-
Choline	g/kg	-	-	-	-	-	-	-	-	-	-
Copper	g/kg	-	-	-	17	20	-	-	12	-	-

Iron	g/kg	-	-	-	756	0	560	-	523	-	2
Component		Chick Starter	Layer Feed	RDA	Azolla	Duckweed	Microalgae	Salvinia	Water Hyacinth	Water Spinach	
Amino Acids											
Alanine	%	-	-	-	5.8	4.3	7	-	-	-	-
Aspartic acid	%	-	-	-	8.3	6.8	9.2	-	-	-	-
Cystine	%	-	-	-	0.9	-	0.9	1.8		-	-
Glutamic acid	%	-	-	-	9.6		13.7	-	8.8	-	-
Glycine	%	-	-	-	4.9	7.1	4.8	5.8	5.2	-	-
Histidine	%	-	-	-	1.6	3.6	3.7	1.7	1.7	-	-
Isoleucine	%	-	-	-	3.9	1.7	5.8	3.6	5.1	-	-
Leucine	%	-	-	-	8.7	3.6	8.5	7.5	8.4	-	-
Methionine	%	-	-	-	1.5	3.9	2.2	1.4	1.3	-	-
Phenylalanine	%	-	-	-	4.7	0.8	4.3	5	5.2	-	-
Proline	%	-	-	-	4	4.1	3.6	-	-	-	-
Serine	%	-	-	-	4.1	2.9	4.9	-	3.9	-	-
Threonine	%	-	-	-	4.3	2.6	4.8	4.8	-	-	-
Tryptophan	%	-	-	-	1.2	3.1	1.4	1.1	-	-	-
Tyrosine	%	-	-	-	3.1	2.7	4.4	3.5	-	-	-
Valine	%	-	-	-	4.5	4.3	6.4	5.3	5.6	-	-

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