Nutritional profile of Quorn™ mycoprotein

Contents

What is mycoprotein?

- Mycoprotein is the ingredient common to all Quorn™ products
- A completely meat-free form of high quality protein
- A good source of dietary fibre
- Low in fat and saturates
- Contains no cholesterol and no trans fats
- Made in fermenters by adding oxygen, nitrogen, glucose and minerals to a fungus called fusarium venetatum

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Nutritional composition of mycoprotein

Nutrient	Amount per 100g*
Energy (kcals)	85
Protein (g)	11
Carbohydrate (g)	9
Sugars (g)	0
Fat (g)**	3
saturates (g)	0.7
Fibre (g)	6
b-glucan (g)	4
w-3 Linolenic acid (g)	0.4
Calcium (mg)	42.5
Magnesium (mg)	45
Zinc (mg)	9
Iron (mg)	0.5
Potassium (mg)	100
Vitamin B1 Thiamin (mg)	0.01
Vitamin B2 Riboflavin – (mg)	0.23
Vitamin B3 Niacin (mg)	0.35
Vitamin B5 Pantothenic acid (mg)	0.25

	Amount per 100g*
Biotin (mg)	0.02
Phosphorous (mg)	260
Copper (mg)	0.5
Manganese (mg)	6
Selenium (ug)	20
Chromium (ug)	15
Molybdenum (ug)	<25
Sodium (mg)	5
Salt (g)	0.0125

Table 1: Nutritional composition of mycoprotein
Source; Marlow Foods
* Wet weight; ie as consumed. For conversion to dry weight, multiply by 4
** AOAC method used

Protein content of Mycoprotein

- Mycoprotein is an excellent source of high quality protein
- Contains all nine essential amino acids for adults
- Protein Digestibility-Corrected Amino Acid Score (PDCAAS) for mycoprotein is 0.99, better than beef at 0.92
- Because of the other protein source in Quorn pieces (egg albumen) the PDCAAS for Quorn pieces is 1.0
- Table 2 compares the PDCAAS of selected food proteins

Protein content of mycoprotein

Protein Digestibility Corrected Amino Acid Score (PDCAAS) of Selected Food Proteins		
Protein Source	**PDCAAS**	**Data Source**
Quorn pieces	**1.0**	**(iv)**
Casein	1.0	(i)
Egg white	1.0	(i)
Chicken (light meat-roasted)	1.0	(iii)
Mycoprotein	**0.99**	**(iv)**
Turkey (ground-cooked)	0.97	(iii)
Fish (Cod-dry cooked)	0.96	(iii)
Soybean protein	0.94	(ii)
Beef	0.92	(i)
Pea flour	0.69	(i)
Kidney beans (canned)	0.68	(i)
Rolled oats	0.57	(i)
Lentils (canned)	0.52	(i)
Peanut meal	0.52	(i)
Whole wheat	0.40	(i)
Wheat gluten	0.25	(i)

Table 2: Protein Digestibility Corrected Amino Acid Score (PDCAAS) of Selected Food Proteins

Sources:
(i) FAO/WHO Joint Report 1989;
(ii) Sarwar and McDonough, 1990.
(iii) Calculated from amino acid data in USDA Nutrient Data Base for Standard Reference, March 12, 1998 (assumes a digestibility equivalent to beef = 94%).
(iv) Calculated from Marlow Foods data.

Fibre content of mycoprotein

- Mycoprotein contains 6g of dietary fibre per 100g
  - 12% soluble
  - 88% insoluble
- Mycoprotein contains more fibre per 100g than potatoes, baked beans, brown bread and brown rice
- The fibre in mycoprotein is primarily polymeric n-acetyl glucosamine (chitin) and beta1,3 and 1,6 glucan
  - 35% chitin
  - 65% B-glucan
- Table 3 compares the fibre content of mycoprotein with selected foods

Fibre content of mycoprotein

Food	Approximate fibre per 100g
Mycoprotein	6.0g
Baked beans in tomato sauce	3.7g
Boiled potatoes	1.2g
Brown bread	3.6g
Brown rice	0.8g

Table 3: Fibre content per 100g of selected foods
Data source for mycoprotein, Marlow Foods
Data source for other foods; MeReC Bulletin Vol. 14 No 6, 2004

Fat profile of mycoprotein

- Mycoprotein contains 3g of fat per100g
  - Lean rump steak contains 5.9g fat per 100g
  - Rump steak with fat on contains 12.7g per 100g
- Mycoprotein contains 0.4g of saturated fat per100g
- It provides both of the essential polyunsaturated fatty acids – linoleic acid belonging to the n-6 series and α-Linolenic acid belonging to the n-3 series
- It contains no trans fats or cholesterol
- There are very small amounts of cholesterol and trans fats in some Quorn products, the cholesterol being present in tiny amounts in the egg white used in production and the trans fats as a trace component of other ingredients used
- Table 4 compares the fat profiles of selected Quorn products wirth their meat equivalents

Fat in Quorn products

Food	Cals/100g	Total Fat (g/100g)	Sat Fat (g/100g)	Cals from Total Fat	Cholesterol (mg/100g)
Quorn Mince (frozen)	94	2	0.5	19%	0
Beef Mince (Raw)*	225	16.2	6.9	65%	60
Quorn Burger (frozen)	146	4.8	0.5	30%	0
Beefburger (raw)*	291	24.7	10.7	76%	76
Quorn Southerrn Style Nuggets	207	11	1.3	48	0
Breaded Nuggets *	265	13	3.3	44	54

Table 4; Fat profile of selected Quorn products compared with meat equivalents
* Source: McCance and Widdowson 'The Composition of Foods' Sixth Edition.

Sodium content of mycoprotein

- Mycoprotein contains 5mg of sodium per 100g
- Sodium content of Quorn Mince is 0.2g (0.5g salt) per 100g
- For Quorn pieces the sodium content is 0.3g (0.75g salt) per 100g
- For comparison, sirloin steak contains approximately 0.2g of sodium (0.5g salt) per 100g

Vitamin & mineral content of mycoprotein

Nutrient	Beef Mince (raw)	Chicken Meat (raw average)	Mycoprotein
Vitamin A (retinol) (ug/100g)	Tr	11	0
Vitamin B1 (thiamine)	0.06	0.14	0.01
Vitamin B2 (Riboflavin)	0.13	0.18	0.23
Vitamin B3 (niacin)	5.8	7.8	0
Vitamin B5 (Pantothenic acid)	0.53	1.16	0
Vitamin B6 (pyridoxine)	0.37	0.38	0
Vitamin B7 (Biotin) (ug/100g)	2	2	0.02
Vitamin B9 (Folate) (ug/100g)	17	`9	10
Vitamin B12 (cyanocobalamin) (ug/100g)	2	Tr	0
Vitamin C	0	0	0
Vitamin D (ug/100g)	0.7	0.1	No data
Vitamin E	0.17	0.15	0

Table 5 Vitamin and mineral content of beef mince, chicken meat and mycoprotein
Source: McCance and Widdowson 'The Composition of Foods' Sixth Edition.
All data mg/100g raw unless otherwise stated

Vitamin & mineral content of mycoprotein

Nutrient	Beef Mince (raw)	Chicken Meat (raw average)	Mycoprotein
Sodium	80	77	5
Potassium	260	380	100
Calcium	9	6	42.3
Phosphorous	160	160	260
Selenium (ug/100g)	9	13	20
Magnesium	17	26	45
Zinc	3.9	1.2	9

Table 5 Vitamin and mineral content of beef mince, chicken meat and mycoprotein
Source: McCance and Widdowson 'The Composition of Foods' Sixth Edition.
All data mg/100g raw unless otherwise stated

Health benefits of mycoprotein – Cholesterol reduction

- A number of studies suggest that mycoprotein is associated with a reduction in LDL cholesterol levels
- Further research is required before any claim could be made for the cholesterol lowering properties of mycoprotein but the results of those studies which have been conducted are promising

- Turnbull and colleagues(1) carried out a three week non-blinded randomised controlled metabolic study investigating the effects of consuming mycoprotein daily on the cholesterol levels of 17 healthy adults with a baseline total cholesterol concentration of 5.2–6.2 mmol/L
- The authors reported a 13% reduction in plasma cholesterol in the intervention group, a 9% reduction in LDL cholesterol and a 12% increase in HDL cholesterol, compared with a 12% increase in LDL cholesterol in the control group and an 11% decrease in HDL cholesterol
- When comparing the intervention group with the control group, the overall reduction in total cholesterol was 14.3%
- The authors concluded "it is clear from these results that lipid variables are advantageously altered by mycoprotein consumption“

1. Turnbull WH, Leeds AR, Edwards GD. Effect of mycoprotein on blood lipids, Am J Clin Nutr 1990;52:646-50

Health benefits of mycoprotein – Cholesterol reduction

- In a second study(2) researchers investigated the effects of mycoprotein on blood lipid profiles of free living subjects consuming their normal diets, supplemented with mycoprotein
- In this single-blind randomised placebo-controlled study, 21 subjects with a baseline total cholesterol concentration of >5.2 mmol/L followed a diet supplemented with either mycoprotein-containing or soya-containing cookies
- No significant changes in HDL cholesterol concentrations were observed in the study but LDL cholesterol decreased by 21.5% in the intervention group, compared with an 8.9% reduction in the control group, giving an overall reduction in LDL cholesterol of 12.8% when compared with the control group
- The authors concluded: "we are relatively confident that mycoprotein exerts a beneficial effect on blood lipids"

2. Turnbull WH, Leeds AR, Edwards DG. Mycoprotein reduces blood lipds in free-living subjects, Am J Clin Nutr 1992; 55:415-9

Health benefits of mycoprotein – Satiety

- A number of studies have investigated the effect of mycoprotein on satiety compared with other protein sources, generally chicken
- Further research is required to understand the satiating benefits of mycoprotein

- Burley *et al* (1993) investigated the effects of mycoprotein versus chicken on satiety in eighteen lean healthy male and female subjects. The two lunches were matched for energy and protein content, but the mycoprotein meal was higher in fibre (11g compared with 3g in the chicken meal)
- Subjects consumed the test lunch, then a meal in the evening. The study had a cross over design, so that all subjects completed two study days, one each for the mycoprotein and chicken test meals
- Energy intake at the evening meal was reduced by 18% following the mycoprotein meal. Self reported food intake indicated that subjects did not compensate for the decreased energy intakes by consuming more
- The authors speculated that, as mycoprotein appeared to have a greater satiating power than other foods with a similar fibre content, the specific types of fibre present might have strong effects on satiety (Burley *et al* 1993)

Health benefits of mycoprotein – Satiety

- Turnbull *et al* (1993) conducted a similar study in thirteen lean healthy female subjects, also using a crossover design. Subjects were given either a chicken or mycoprotein test lunch
- Ratings of appetite were taken just before the test meal and at intervals for three hours following. Palatability of the two meals was also measured and the ratings did not vary significantly between the mycoprotein and chicken lunches. Energy intake was recorded by subjects using a food diary for the days before, during and after the study
- According to the food diaries, energy intake was reduced by 24% and 16.5% on the day of the study and the following day, respectively, after eating the mycoprotein lunch compared with the chicken lunch
- Measures of subjects' desire to eat and prospective food consumption were also reduced when measured three hours after the mycoprotein versus the chicken lunch.
- Authors suggested that mycoprotein fibre seemed to be particularly satiating compared with studies using different types of fibre, particularly as the majority of fibre in mycoprotein is insoluble and the strongest satiating affects tend to be seen with soluble fibres (Turnbull *et al* 1993)

Health benefits of mycoprotein – Glycaemic response

- There is evidence to suggest that mycoprotein may be useful in the management of obesity and type 2 diabetes as it appears to show beneficial effects on glycaemia (glucose in the blood) and insulinaemia (insulin in the blood)

- Turnball & Ward (1995) investigated the glycaemic response in 19 healthy subjects. The study was a randomised crossover design with each subject receiving either a test meal (20g mycoprotein) or control meal, in random order, with a 7-day washout period between the two meals
- They observed that the serum glucose response was lower throughout the entire 120 minute post-prandial period following the mycoprotein meal compared to the control. The insulin response was also lower. The only nutritional difference between the test meals was the dietary fibre content (the mycoprotein meal contained 11.2g more dietary fibre) so the authors suggest that it is the viscous polysaccharides that are reducing postprandial glycaemia and insulinaemia
- The mechanisms by which mycoprotein reduces the rise in postprandial blood glucose are thought to be associated with its high fibre content. Fibre delays the passage of food into the small intestine (Leclère *et al*. 1994)
- As a result, the glucose is absorbed more slowly. Additionally, the presence of soluble, viscous fibre slows the diffusion of glucose across the small intestinal wall bringing about an improved glycaemic response (Edwards *et al*. 1988)

How mycoprotein is made

- Mycoprotein is made in 40 metre high fermenters
- The fermenter is sterilised and filled with a water and glucose solution
- Then a batch of fusarium venenatum, the fungi at the heart of mycoprotein, is introduced
- Once the organism has started to grow a continuous feed of nutrients, including potassium, magnesium and phosphate as well as trace elements, is added to the solution
- The organism and nutrients combine to form mycoprotein solids and these are removed from the fermenter every five to six hours
- Once removed, the mycoprotein is heated to 65°C in order to breakdown the nucleic acid
- Water is then removed in huge centrifuges, leaving the mycoprotein looking rather like pastry dough
- The mycoprotein is then mixed with a little free range egg and seasoning to help bind the mix. It is then steam cooked for about 30 minutes and then chilled and chopped into pieces or mince
- The product is then frozen. This is a crucial step in the process because the ice crystals help to push the fibres together, creating bundles that give mycoprotein its meat-like texture

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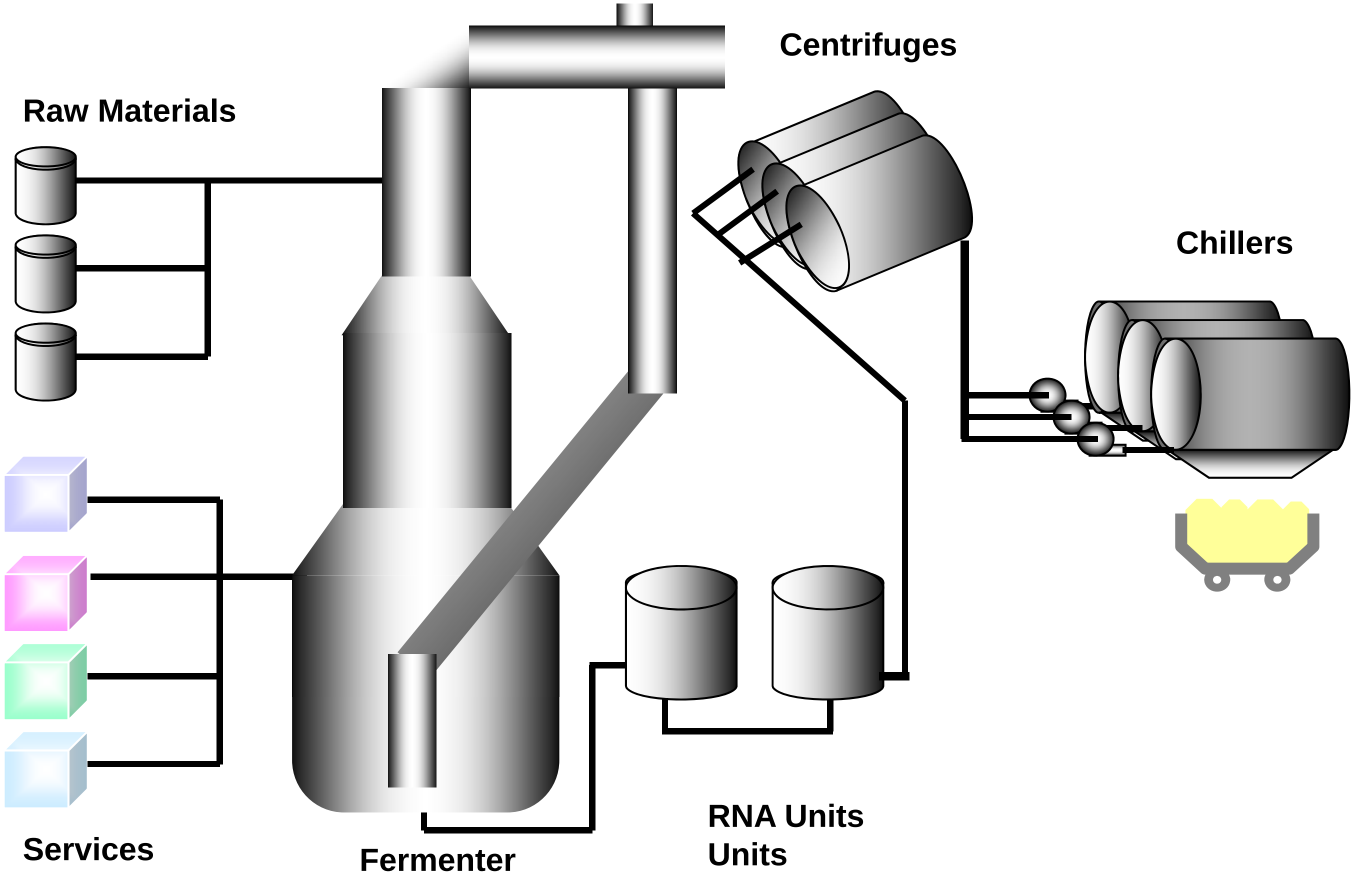
How mycoprotein is made



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- Effects of consuming mycoprotein, tofu or chicken upon subsequent eating behaviour, hunger and safety; Williamson et al; Appetite 46 (2006) 41-48