

NUTRIENT ANALYSIS OF PASTA AND PASTA SAUCES

Summary

The Food Standards Agency has recently carried out a survey to determine the nutrient composition of a wide range of pasta and pasta sauces. The survey forms part of the Agency's rolling programme of nutrient analysis that provides reliable information on the nutrient content of foods. These data are incorporated into the Agency's nutrient databanks, which support our national dietary surveys.

Thirty six composite samples of pasta and pasta sauces were analysed for energy and a range of nutrients including fat, protein, carbohydrate, fibre and a full range of vitamins and minerals. Comparison with previous data where available, showed that levels of most nutrients were in general, very similar to those measured previously.

The results of this survey are being incorporated into the Agency's nutrient databanks used in dietary surveys to monitor the nation's diet and future publications of *McCance and Widdowson's The Composition of Foods* series.

Background

The Food Standards Agency undertakes a rolling programme of nutrient analysis to ensure reliable information on the nutritional value of foods is available for use in conjunction with food consumption data collected in dietary surveys to monitor the nutritional value of the nation's diet. Therefore, these nutrient surveys need to provide a single, robust set of nutrient values that is indicative of the potentially broad choice available to the consumer when selecting any particular type of food. As a result, composite samples made up of a number of different brands have been analysed for this survey rather than samples made up of single brands, and a generic name is given to each composite. For this reason, this survey is excluded from the Agency's policy of naming the individual products analysed when the results are published.

The aim of this survey was to update and extend information on a range of pastas and pasta sauces that have been previously analysed for a range of nutrients^{1,2,3,4} and to provide information on new products which have become more popular and widely available in recent years, such as fresh pasta sauces and fresh filled pasta. This survey has also provided updated information on the salt content of pasta and pasta sauces, and of pasta cooked in salted and unsalted water.

Methodology

Three hundred and twenty six samples of pasta and pasta sauces were purchased in the South East England region of the UK during March to July 2002. The retail samples were then combined into 36 composite samples for analysis. Market share information was used to determine which sub-samples were included in each composite. This process allows a single, robust set of nutrient values to be derived for each product type, covering an appropriate cross-section of retail products available. Samples requiring preparation/cooking were prepared in accordance with the manufacturer's instructions and using normal domestic practices. In general, 100g of each sample of raw pasta was boiled in 1 litre of tap water. Equal weights of each pasta sample were then combined to form the composite sample. A separate sample, boiled in salted water, had 5g of salt added to the cooking water. A full list of the composite food samples analysed is given in Table 1.

The full sampling report is available in hard copy through the Food Standards Agency library (contact details given in Further Information).

The composite samples were analysed by the Laboratory of the Government Chemist (LGC) for energy and a range of nutrients including fat, protein, carbohydrate, fibre and a full range of vitamins and minerals, depending on the importance of a particular food as a dietary source for each nutrient, and existing compositional data available. Some samples were not analysed but were boiled in water in accordance with the manufacturer's instructions in order to obtain the weight gain on cooking for these samples. New analyses were undertaken to ascertain the lycopene and lutein content of the ambient tomato-based pasta sauces. These are carotenoids that do not have vitamin A activity, but have a beneficial role as antioxidants in the body. Lycopene, mainly found in tomatoes, is released on cooking and is therefore found in higher amounts in cooked or processed tomatoes than fresh. A full list of nutrients is given in Table 2. The methods used to conduct the analyses are included at Annex One.

Results

As each of the composite samples was analysed for an extensive range of nutrients, this project generated a large number of individual results. The main results are shown in Table 3. The full set of results are provided in the analytical report which is available in hard copy through the Food Standards Agency library (contact details given in Further Information).

Where some comparisons to earlier data are possible (i.e. dried white and wholemeal pasta/spaghetti raw and boiled, dried egg noodles raw and boiled, fresh egg pasta raw, fresh pasta filled with green vegetables/herbs and cheese boiled, tomato based pasta sauce and canned spaghetti and canned ravioli in tomato sauce) the levels of nutrients were generally similar to those found previously.

Interpretation

This survey has generated new data where none were previously available, updated existing data, and has provided information on new products that have become more popular and widely available in recent years. The data from this survey will enable us to more accurately monitor the nutritional value of the nation's diet. The results of this survey will be incorporated into the Agency's nutrient databanks for current and future surveys, together with future publications in the *McCance and Widdowson's The Composition of Foods* series.

References

1. Laboratory of the Government Chemist (1980) Cereals Study.
2. Holland, B., Unwin, I.D. and Buss, D.H. (1988) *Cereals and Cereal Products*. Third supplement to 4th edition of *McCance and Widdowson's The Composition of Foods*. The Royal Society of Chemistry, Nottingham.
2. RHM Technology (1995) Nutrient analysis of selected foods. (Food Surveillance Information Sheet No. 70).

4. Leatherhead Food RA (1992) Nutritional Analysis of Miscellaneous Foods.

Further information

The report of this survey (entitled Nutrient Analysis of Pasta and Pasta Sauces) is held in the Dr Elsie Widdowson Library and Information Service at the Food Standards Agency headquarters in London. If you would like to consult or receive a copy, please contact:

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Table 1: Details of Composite Samples Analysed

Sample	Food group
1	Dried white pasta shapes, raw
2	Dried white egg pasta shapes, raw
3	Dried flavoured/coloured pasta shapes, raw
4	Dried wholewheat spaghetti, raw
5	Dried egg noodles, raw
6	Dried white pasta twists, boiled in unsalted water
7	Dried white pasta twists, boiled in salted water
8	Dried white pasta tubes, boiled in unsalted water
9	Dried white shells, boiled in unsalted water
10	Dried white bows, boiled in unsalted water
11	Dried white macaroni, boiled in unsalted water
12	Dried white spaghetti, boiled in unsalted water
13	Dried wholewheat spaghetti, boiled in unsalted water
14	Dried egg noodles medium, boiled in unsalted water
15	Dried egg noodles fine, boiled in unsalted water
16	Dried egg noodles thick, boiled in unsalted water
17	Dried rice noodles fine, boiled in unsalted water
18	Fresh egg pasta shapes, raw
19	Fresh white egg tagliatelle, boiled in unsalted water
20	Fresh egg pasta filled with cheese only, boiled in unsalted water
21	Fresh egg pasta filled with cheese and tomato, boiled in unsalted water
22	Fresh egg pasta filled with mushrooms, boiled in unsalted water
23	Fresh egg pasta filled with green vegetables/herbs and cheese, boiled in unsalted water
24	Fresh egg pasta filled with meat, boiled in unsalted water
25	Ambient tomato-based sauce - for bolognese
26	Ambient/fresh tomato-based sauce - napoletana
27	Ambient tomato based sauce – lower in fat
28	Ambient and fresh tomato based sauce with added vegetables
29	Pesto sauce, green

30	Pesto sauce, red
31	Fresh chilled/ambient four cheese pasta sauces
32	Fresh chilled/ ambient carbonara type pasta sauces
33	Dried pasta and sauce mixes, raw
34	Dried pasta and sauce mixes, cooked
35	Canned spaghetti in tomato sauce
36	Canned Ravioli in tomato sauce

Table 2: List of Nutrients Analysed

Proximates	Water Protein (nitrogen and nitrogen factor) Fat Dry Ash content
Fatty acids	Individual fatty acids (<i>cis</i> and <i>trans</i> isomers, positional isomers, branched chain) (Expressed as percentage total fatty acids, and per 100g food)
Sterols	Cholesterol and other main sterols (brassicasterol, campesterol, stigmasterol, beta-sitosterol, fucostanol, d5-avenasterol, d7-stigmastenol, d7-avenasterol)
Carbohydrate	(All expressed as monosaccharide equivalents) Starch, total sugars, total carbohydrate, glucose, fructose, sucrose, maltose, lactose, galactose, oligosaccharides, maltodextrins, resistant starch
Fibre	As non-starch polysaccharide i.e. Englyst method, and AOAC method
Inorganics	Sodium, potassium, calcium, magnesium, manganese, phosphorus, iron, zinc, copper, iodide, selenium, chloride.
Water soluble vitamins	Thiamin, vitamin B ₆ , niacin, folate, riboflavin, vitamin B ₁₂ , biotin, pantothenic acid, tryptophan (to calculate niacin equivalent), vitamin C
Vitamin A	13- <i>cis</i> retinol, <i>all trans</i> retinol, carotenoids (alpha and beta-carotene).
Other carotenoids	Lutein, <i>cis</i> and <i>trans</i> lycopene
Vitamin D	Vitamin D ₃
Vitamin E	All tocopherol fractions

Note: Each of the samples was analysed for a range of nutrients in the above list, depending on existing compositional data available and the importance of the particular food as a dietary source of each nutrient.

Annex 1: Analytical Methods Used

Moisture:

Samples were oven dried at 101°C plus or minus 2°C for 2 hours and then to constant weight. UKAS accredited method.¹

Ash:

Samples were ashed at 550°C plus or minus 50°C for 8 hours and then reweighed. In house method FFF/B1-0005 - UKAS accredited.²

Protein:

Nitrogen was determined by Dumas combustion using a LECO 2000 CNS analyser. In house method FFF/B1-0010 - UKAS accredited. The nitrogen was converted to protein using the factors detailed in the analytical report.

Fat:

Fat was determined using standard method BS 4401: Part 4: Method A UKAS accredited method.³ The fat factors used are detailed in the analytical report.

Fatty Acids:

Fatty acids were determined by gas chromatography using a modified IUPAC method.⁴ A dual column procedure using an internal standard was employed to give cis and trans results as milligram/100g of food. In house method FFF/B1-4002 - UKAS accredited.

Sugars:

Free sugars were determined using a Dionex ion chromatography system with electrochemical detection. Results are expressed as monosaccharide equivalents. In house method FFF/B1-3007 - UKAS accredited.

Starch:

Starch was determined polarimetrically based on the method described in the Official Journal of the European Communities.⁵ The results are expressed as monosaccharides equivalents. In house method FFF/B1-3101 - UKAS accredited.

Oligosaccharides:

None of the products analysed were expected to contain significant levels of oligosaccharides, therefore these were not determined. Total carbohydrate was also determined after hydrolysis, using Dionex HPLC and this data generally agreed with the sum of the free sugars and Ewer's starch determinations within the uncertainty of the methods used.

Available carbohydrate:

This was calculated by the sum of the free sugars and starch, expressed as monosaccharide equivalents.

Dietary Fibre:

Two methods were employed and results expressed as polysaccharides.

1. Englyst Fibrezym kit with colorimetric end point
2. AOAC Official Method 985.29.⁶

Inorganics:

Sodium, potassium, calcium, magnesium, copper, iron, manganese, zinc, and phosphorus were determined by Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) after microwave digestion with nitric acid and hydrogen peroxide. In house method FFF/B1-2005 - UKAS accredited.

Selenium:

Selenium was determined by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) after microwave digestion with nitric acid and hydrogen peroxide. In house method FFF/B1-2005 - UKAS accredited.

Chloride:

Chloride was determined using a Corning Chloride Analyser after extraction with nitric acid. In house method FFF/B1-2104 - UKAS accredited.

Iodine:

Iodine was determined by calibration using a Finnigan MAT Element sector field ICP-MS operating in low resolution (R=300, 10% valley definition) mode after extraction with TMAH solution (tetra-methyl ammonium hydroxide). Tellurium (Te) was used as an internal

standard to account for instrumental drift. Each analysis comprises 1000 replicate measurements of the $^{127}\text{I}/^{125}\text{Te}$ ratio. Instrumental quality assurance was maintained throughout the procedure by repeat analysis of a mid-point calibration standard. Cleaned glassware was used throughout the procedure to limit the effects of iodine contamination from plastic.

B Vitamins:

The vitamins of the B group: niacin, B₆, B₁₂, pantothenic acid, folate and biotin were determined using semi-automated versions of the methods by Bell.⁷ Thiamin and riboflavin was determined by HPLC using fluorescence detection. UKAS accredited methods.

The B-vitamin results are expressed as follows:

Thiamin: Thiamin chloride hydrochloride

Riboflavin: free riboflavin

Niacin: nicotinic acid

Vitamin B₆: pyridoxine

Pantothenate: pantothenic acid

Biotin: d-biotin

B₁₂: cyanocobalamin

Total folate: pteroylglutamic acid

Tryptophan (to calculate niacin equivalent):

Tryptophan was determined after alkaline hydrolysis by high performance liquid chromatography using fluorescence detection. Niacin equivalent is calculated as niacin, plus Tryptophan \div 60.

Vitamin C:

Vitamin C was determined by HPLC using fluorescence detection.

Oil Soluble Vitamins:

Vitamins A, D, E, alpha and beta-carotenes were determined using an in house procedure involving saponification of the sample, solvent extraction and HPLC determination - UKAS accredited.^{8,9,10,11}

Vitamin E (ie alpha-tocopherol equivalents) takes into account the relative biological activities of the different isomers. The activities used for these calculations are as shown below:

alpha - tocopherol	1.0
beta - tocopherol	0.4
gamma - tocopherol	0.1
delta - tocopherol	0.0

Total vitamin A is expressed as all-trans retinol equivalent (ATRE) and is calculated as follows:

$All-trans \text{ retinol} + (13-cis \text{ retinol} \times 0.749) + (trans \text{ beta-carotene} \div 6) + (\text{other active carotenoids} \div 12)$

Lutein and Lycopene

Lutein and lycopene were determined using an in house procedure involving saponification of the sample, solvent extraction and HPLC determination.

Sterols:

Sterols were determined by capillary gas chromatography using a CP Sil- 19CB column using betulin as an internal standard. The samples were saponified and extracted with ether; sterols were separated from impurities by TLC and the trimethylsil derivative determined by gas chromatography. In house method FFF/B1-4003 - UKAS accredited.

Details of the quality control measures employed are given in the analytical report, available in hard copy through the Food Standards Agency library (contact details given in Further Information).

¹ BS4401-3: 1997, ISO 1442:1997. Methods of Test for Meat and Meat Products. Part 3: Determination of Moisture Content (Reference Method).

² BS4401-1: 1998, ISO 936:1998. Methods of Test for Meat and Meat Products. Part 1: Determination of Total Ash.

³ BS4401-4: 1970. Methods of Test for Meat and Meat Products. Part 4: Determination of Total Fat Content: Method A (Weibull Stoldt).

⁴ IUPAC (1987) Standard Methods for the Analysis of Oils, Fats and Derivatives.7th edition. Method 2.301: Preparation of fatty acid methyl esters and Method 2.302: Gas liquid chromatography of fatty acid methyl esters.

⁵ Determination of Starch- Polarimetric Method. Official Journal of the European Communities 72/199/EEC, no. L123/6, 25/9/1972.

⁶ AOAC Official Method 985.29: Total soluble and insoluble fibre in foods. Enzymatic-gravimetric method.

⁷ Bell, J.G. (1974) Microbiological assay of vitamins of the B group in foodstuffs. Laboratory Practice, 1974, 23, 235-242, 252.

⁸ BS EN 12823-1:2000. Foodstuffs-Determination of Vitamin A by High Performance Liquid Chromatography-Part 1: Measurement of Retinol.

⁹ BS EN 12823-2:2000. Foodstuffs-Determination of Vitamin A by High Performance Liquid Chromatography-Part 2: Measurement of beta-Carotene.

¹⁰ BS EN 12821:2000. Foodstuffs-Determination of Vitamin D by High Performance Liquid Chromatography- Measurement of Cholecalciferol (D3) and Ergocalciferol (D2).

¹¹ BS EN 12822:2000. Foodstuffs-Determination of Vitamin E by High Performance Liquid Chromatography- Measurement of alpha, beta, gamma and delta tocopherols.