

Pasta and Semolina Technology

Edited by
R.C. Kill
and
K. Turnbull



**Blackwell
Science**

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Blackwell Wissenschafts-Verlag GmbH
Kurfürstendamm 57
10707 Berlin, Germany

Blackwell Science KK
MG Kodenmacho Building
7-10 Kodenmacho Nihombashi
Chuo-ku, Tokyo 104, Japan

Iowa State University Press
A Blackwell Science Company
2121 S. State Avenue
Ames, Iowa 50014-8300, USA

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First published 2001

Set in 10/12pt Times
by DP Photosetting, Aylesbury, Bucks
Printed and bound in Great Britain by
MPG Books Ltd, Bodmin, Cornwall

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trade mark of Blackwell Science Ltd,
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DISTRIBUTORS

Marston Book Services Ltd
PO Box 269
Abingdon
Oxon OX14 4YN
(Orders: Tel: 01235 465500
Fax: 01235 465555)

USA and Canada
Iowa State University Press
A Blackwell Science Company
2121 S. State Avenue
Ames, Iowa 50014-8300
(Orders: Tel: 800-862-6657
Fax: 515-292-3348
Web: www.isupress.com
email: orders@isupress.com

Australia
Blackwell Science Pty Ltd
54 University Street
Carlton, Victoria 3053
(Orders: Tel: 03 9347 0300
Fax: 03 9347 5001)

A catalogue record for this title
is available from the British Library

ISBN 0-632-05349-6

Library of Congress
Cataloging-in-Publication Data
is available

For further information on
Blackwell Science, visit our website:
www.blackwell-science.com

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Preface

When we were asked by the publisher to put together a book on current practices in pasta and semolina manufacture there was no hesitation on our part. It appeared to us that there had not been such a book for too long and we hope that we have achieved our aim. We felt that for some time now there has been a need for a book which examined the latest technologies in a practical way. To this end we have obtained contributions from some of the manufacturers at the leading edge of technological development in semolina milling and pasta manufacture.

In keeping with our aim of producing a practical guide to this industry, in addition to the general information given, some of the chapters also include trouble shooting sections.

Occasional reference is made in the text to particular manufacturers' names and items of equipment. In no case should any such reference be taken to imply endorsement by the authors over any similar product.

We have tried to cover all aspects of the production process, from farm to factory gate and our contributors from many different parts of the industry have made this an interesting and challenging task. We thank them all.

R.C. Kill
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1 Introduction

R.C. Kill

Just a few steps from the cascades of the Trevi Fountain in Rome, which is always so full of noise and life, is the Piazza Scandenberg. This is a rather quiet corner slightly off the tourist beat but in it you can find the world's first museum devoted to pasta, the National Museum of Pasta Foods.

It is entirely appropriate that this should be in the capital city of Italy. Although there are opinions that pasta originated far from Italy, perhaps in China, it is to Italy that westerners owe a debt of gratitude for the development of this simple but versatile food.

The museum is unusual, informative and entertaining, and well worth a visit for anyone interested in pasta. My visit provided some useful information for this introduction and I am grateful for the hospitality of the staff there.

1.1 WHAT IS PASTA?

The word 'pasta' is the Italian for 'dough'. The usual basic ingredients are wheat flour or semolina and water. Alternatives include potato flour (used in gnocchi) and maize flour (in gluten-free product). Additional ingredients include egg, natural colourants such as spinach, tomato and in the case of some product for the USA, vitamins.

Essentially, though, most pasta in the Italian style is made from semolina from hard wheat and water. It is therefore a very simple food. This is especially so when it is made in the kitchen or restaurant and served after cooking within a short time of being made. The art of pasta making as described in this book takes us far from the kitchen and into highly sophisticated industrial techniques. The result of all that sophistication is still a very simple product with few ingredients. The techniques are applied to produce firstly a large range of shapes and sizes of the product and secondly a stable, dry product that has a long shelf life.

It is true that there is a growing market for so-called 'fresh' pasta, i.e. pasta that has not been dried. However the convenience, quality and cheapness of dry pasta for the retailer and consumer make this sector of the market by far the largest. Indeed some argue that it is difficult to justify the

cost of fresh pasta to the consumer when the manufacturer has not had to bear the cost of drying and where the product yield is significantly greater because it contains far more water.

It is with dry pasta that the bulk of the market lies and this book is devoted to the modern technology of the production of this Italian-style pasta.

1.2 PASTA'S PAST

A good deal has been written and discussed in the past about the origins of pasta. In particular Italian authors are keen to point out that despite indications of the possible birthplace being China, very early evidence of pasta can be traced to Italian soil in the form of the Etruscan civilisation, several centuries BC. Speculation on pasta and its conception even include Italian mythological stories (Agnesi, 1996). They are fun, but it seems to this author for it not to be beyond the wit of humankind to have invented this fundamentally simple food several times over at several locations. This is particularly possible since the usual ingredients – milled wheat or other cereal and water – are almost universally available and have been since our early history.

It is not intended to say much more of the history of pasta in this book, although there are three points all concerning the development of pasta in Italy that are worth noting.

Many centuries after the origins of pasta, by the sixteenth century, pasta makers in Italy were well established and organised into trade associations. There were rules already established about trading and recipes. Today the industry in Italy is highly regulated. For example, manufacturers there are not permitted to produce from anything other than durum wheat unless a special licence is obtained (this is true even of 'wholewheat' durum pasta). These constraints in Italy may have helped to perpetuate the belief elsewhere that good quality pasta may only be made from durum wheat.

Pasta making in Italy had become something of a Neapolitan speciality by the nineteenth century and it was in Naples that production began to be fully commercialised and industrialised. Drying of pasta as a way of preserving began. This author has always held the romantic notion that the traditional, mechanised drying techniques, still sometimes in use today, were a means of capturing a little of Naples in a cabinet, reproducing the washing line drying of the early street sellers in the Neapolitan air.

The interiors of today's high-speed dryers little resemble that sultry climate, with temperatures as high as 90°C. However the development of these leviathan plants with outputs of many tonnes of product per hour began with this early industrialisation.

It was also probably in the 1800s that the marriage of pasta with tomatoes in cooking occurred. Southern Italy is also ideal for the growing of

tomatoes. The two together provided for countless culinary possibilities and today the two complementary industries are a feature of this area.

1.3 PASTA NOW

Pasta today is a food which is accepted and used all over the world at varying degrees of importance (see section 1.4 below). It is also a sophisticated industry which now utilises advanced technologies to maximise efficiency (see Figs 1.1 and 1.2), output and quality. In contrast with some areas of the food industry (bread would be a good example) it is a tribute to the technicians and engineers involved in these advances that they have managed to make production of this food cheap and plentiful at no cost to the quality.

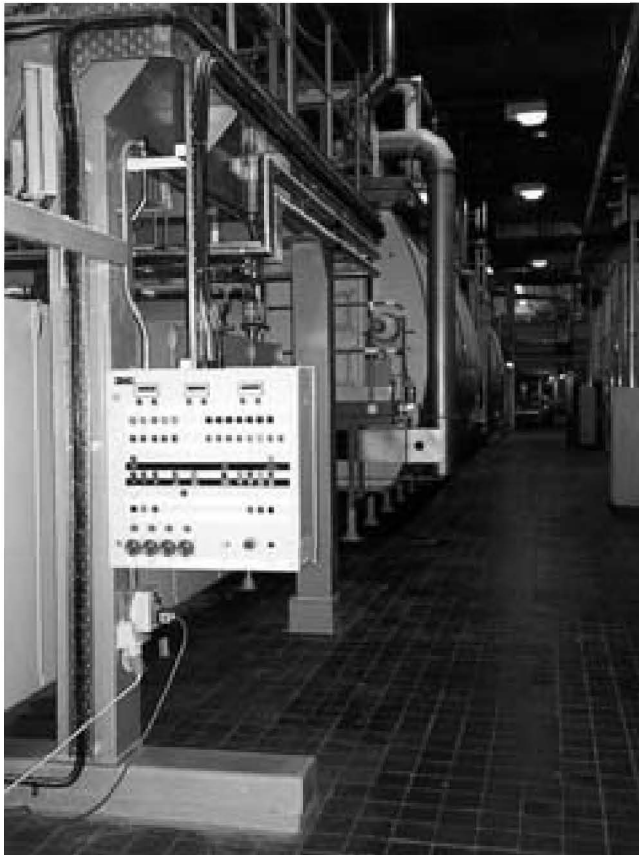


Fig. 1.1 View of part of extruder and drier of a modern plant

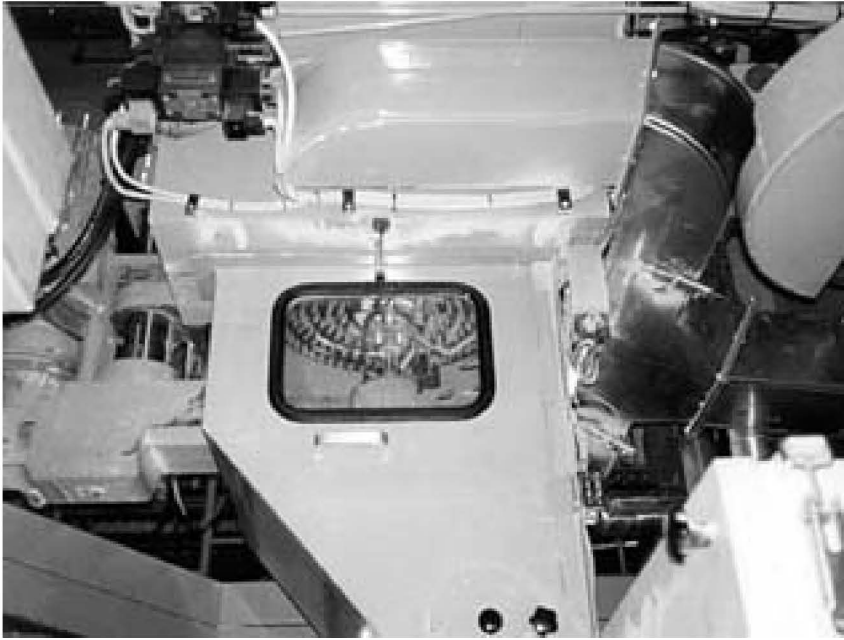


Fig. 1.2 View of extrusion of short cut pasta in a modern pasta plant

It is not possible to discuss pasta without also discussing durum wheat. Their stories are naturally now intertwined. When asked what were the three critical points in making good pasta a manufacturer once replied ‘raw material, raw material, raw material’. We hope to be a little more informative here but can understand what he meant.

Why is durum wheat so important to pasta? Its essential characteristics are its hardness, its gluten quality and its colour. It is quite possible to make pasta products from other wheats, especially other hard wheats. Furthermore, perfectly good and legitimate products are made from mixtures of durum and soft wheats at up to 25% soft wheat. However there is an unmatched eating quality to durum wheat product and the ingredient has become a byword for the best quality pasta.

Because durum wheat commands a premium price over other wheats (see below), in recent years the authenticity of the raw material has become a very important issue. The adulteration of pasta with common or soft wheats is all too easily possible. In Chapter 2 there is a detailed discussion of durum wheat and the history of its development. There is also some new insight into the important issue of authenticity and some fascinating and groundbreaking techniques for the analysis of pasta.

Pasta in the Italian style is almost universally made from the milled

product of durum wheat: semolina. Semolina milling is a specialised part of the wheat milling industry. Particle size and uniformity of particle size are especially important for ease of mixing with water, extrusion and final quality after drying. The absence of specks, dark or light, is also critical for visual, and sometimes physical quality. In Chapter 3 there is a presentation of semolina milling, its history and the very latest techniques.

Durum wheat is grown only in certain parts of the world (see Fig. 1.3), unlike common wheat which can be grown much more widely. The total production varies and estimates for 1999 are for a global crop of about 28.5 million tonnes, a decrease of 6 million tonnes on the previous year. At the time of writing the demand is likely to exceed that figure, whereas in previous years supply has exceeded demand. Not surprisingly for a crop of this nature the price can fluctuate greatly year on year, however there is always a premium over the price of common wheat (van Lit, 1999).

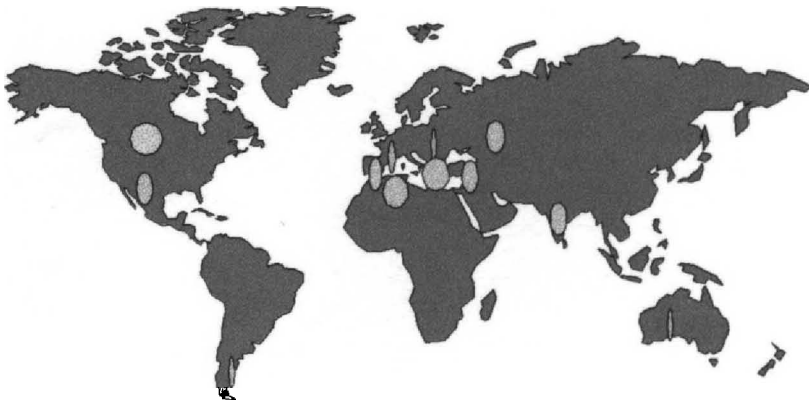


Fig. 1.3 World durum production (van Lit, 1999).

The Mediterranean region produces 55–60% while the North American continent produces about 30% of the world's output. At the same time however the North American continent accounts for 80–90% of the world's exports. The Mediterranean area accounts for 50% of the world's imports.

If raw material is the first critical point in making good quality pasta, the second is the mixing and production of the dough. Semolina is mixed with the other principal 'ingredient' – water – and the quality of both is important. The quotation marks are used here because although a significant amount of water is added to the semolina at this stage, when pasta is dried it is taken down to a moisture content similar to that of the original raw material. Hence water need not appear on ingredient lists, in the EU at least.

Once the dough is made pasta may be produced in one of two ways. It may be simply rolled out into sheets. The thickness of these sheets can be easily varied and then they may be cut into, for example, lasagne sheets or fettuccini strips, or they may be stamped into special shapes such as bows (farfalle) or they may be used to produce filled pasta shapes such as tortellini.

While there are numerous and diverse ways in which sheeted pasta may be used, by far a wider diversity of shapes can be produced courtesy of extrusion techniques. By extruding pasta dough at high pressure through a die not only are the possibilities for shapes almost unlimited, the visual quality of the pasta itself is greatly enhanced.

As elsewhere, the mixing and extrusion stages are tightly controlled techniques. In Chapter 4 detail is provided on the theory of mixing and extrusion and on modern techniques and advances in this area.

As mentioned above, this is a simple food with the minimum of ingredients. Thanks to the diversity of shapes possible with extruded pasta there are any number of products, preparations and meals that can be made with pasta. The forms available range from the traditional long spaghetti products and short cut shapes such as penne to the novelty lines for canning pasta. As a result pasta occupies positions in both adult-oriented cuisine and in children's markets where the latest cinema hit or dinosaurs may yet rule.

The design and production of the dies responsible for all these shapes requires a blend of art and craft, and in a very enlightening and entertaining piece Chapter 5 takes us into the world of pasta die design.

Perhaps the most important advances in the past decade have been in the next critical point in modern pasta making: drying. Ten years ago it was normal for spaghetti drying to take 20 hours or more. At the time the technology was not available to speed this process up and to understand why one must appreciate the difficulties involved in drying this product without drying faults such as internal cracking (still often referred to as 'checking'). Chapter 6 presents the background and theories of drying pasta and brings us up to date with the current technology.

Today a drying time of 3 hours for short cut pasta shapes is possible and this has been brought about by the use of elevated temperatures, reaching 90°C and above. Apart from the obvious advantages of the shorter times involved, it appears that product quality has also benefitted from the new techniques.

Mention was made above of the minimal ingredients used in pasta manufacture. In fact, in addition to the essential presence of semolina, pasta has for many years been coloured by the addition of tomato or spinach. This enables manufacturers to produce a greater variety of products, including tricolore, a red, plain and green mixture coincidentally reminiscent of the Italian flag.

Traditionally in the kitchen egg is typically added to pasta and so too in manufacturing egg pasta is very important. The presence of egg and/or egg albumen adds both strength and colour to the product.

Fortified pasta, made by adding vitamin mixes, is a relatively important variety, mainly for the US market. The presence of vitamins not only adds to the nutritive value of the product, but in the case of riboflavin will also improve colour by giving a yellow tone.

There is a small market for wholewheat pasta. Pasta made from wholewheat is quite different in appearance and texture and naturally has a higher fibre content. In Italy it is considered sufficiently different from plain pasta to be not 'durum wheat' pasta, even though it is generally made from such, and pasta makers there require a licence to produce it just as they do when they are including soft wheats in their mix. In Chapter 7 some details on these additional ingredients are presented.

There are many issues of concern when considering the quality of pasta at all stages of production. These include both quality and safety issues. Examples include drying faults, microbiological load and infestation. In our final chapter, Chapter 8, we address these issues and present plans to minimise quality and safety problems.

1.4 THE MARKET FOR PASTA

Today there is a market for Italian-style pasta all over the world. It may be no surprise that the Italians themselves continue to consume the most per person, but the amount consumed in such diverse countries as Venezuela, Tunisia, Switzerland and Chile is considerable (see Table 1.1).

Figures published over 30 years ago show how much consumption per head in the United Kingdom has increased; in Italy, which still tops the league, there appears to have been a slight decrease per capita.

In the USA a recent survey carried out by the National Pasta Association there has indicated that consumption per head has increased in recent years. The reasons given by consumers are that it is a healthy food that is easy to store at home and is quick and easy to prepare. Sadly for the US manufacturers this increase seems to be supplied by slightly higher imports, mainly from Italy, with a little from Turkey.

In the UK the growth in the market for dry pasta has slowed considerably and is now at about 2% per annum. The market for fresh pasta, although much smaller, is growing at 10% per annum. While the growth may be levelling off, pasta has been accepted by consumers in the UK as a normal part of the diet over the past 20 years and this is underlined by the rapid growth in sales of prepared pasta sauces (currently growing at 18%). Indeed they have probably helped to establish this untraditional food for UK consumers.

Table 1.1 Estimates of national consumption of pasta (sources: Unione Industriali Pasta Italiani; Hummel, 1966).

Country	Kg pasta per person	
	1998	1966
Italy	28.5	30–35
Venezuela	12.7	
Tunisia	11.7	
Switzerland	9.6	
Chile	9.0	
USA	9.0	3.7
Greece	8.5	
Peru	8.0	
France	7.3	6.3
Russia	7.0	
Argentina	6.8	
Portugal	6.5	
Canada	6.3	
Sweden	5.5	
Germany	5.4	
Turkey	5.2	
Bolivia	4.8	
Spain	4.5	
The Netherlands	4.4	
Belgium/Luxembourg	4.3	
Austria	4.0	
Brazil	4.0	
Israel	4.0	
Former Yugoslavia	4.0	
Finland	3.2	
Australia	2.5	
Libya	2.5	
United Kingdom	2.5	0.4
Mexico	2.3	
Costa Rica	2.0	
Denmark	2.0	
Japan	1.7	
Egypt	1.2	
Ireland	1.0	
China	0.8	

Another significant factor in the UK is the very large market for canned pasta. This includes the largely children-oriented market for ‘hoops’ and various theme-based shapes. These tend to be canned in sweet sauces to attract youngsters. On the other hand there is also a significant market still for canned filled pasta such as ravioli, which tends to be aimed at both adults and children.

If you speak to most Italians, while they are happy to manufacture canned products for the UK and other markets, they would rather not partake themselves. The eating qualities of these products are too far removed from the authentic product. Nevertheless in markets that have needed to be educated in the joys of eating 'real' pasta these canned products may have played a part in creating awareness and the acceptability of the authentic product.

Table 1.2 Nutrition values for types of pasta.^a

	Type of pasta					
	Plain		Vitamin enriched	Egg pasta		Cooked spaghetti ^b
<i>Nutrients</i>						
Calories (kcal)	342 ^b	346 ^c	370	380	343 ^c	104
Protein (g)	12 ^b	10 ^c	12.8	14	14 ^c	3.6
Fat (g)	1.8 ^b	1.5 ^c	1.6	4.2	3.0 ^c	0.7
Carbohydrate (g)	74 ^b	52 ^c	74	75	65 ^c	22.2
Dietary fibre (g)	2.9 ^b	3.0 ^c	4.2	4.7	4.0 ^c	1.2
<i>Minerals</i>						
Calcium (mg)	25 ^b		17.5	29		7
Iron (mg)	2.1 ^b		3.8	4.5		0.5
Magnesium (mg)	56 ^b		47	60		15
Phosphorus (mg)	190 ^b		149	214		44
Potassium (mg)	250 ^b		161	233		24
Sodium (mg)	3 ^b	Trace ^c	7	21	20 ^c	Tr
Zinc (mg)	1.5 ^b		1.2	1.6		0.5
Copper (mg)	0.32 ^b		0.2	0.3		0.1
Manganese (mg)	0.9 ^b		0.7	0.7		0.3
<i>Vitamins</i>						
Ascorbic acid (mg)	0 ^b		0	0		0
Thiamin (mg)	0.22 ^b		1	1		0.01
Riboflavin (mg)	0.31 ^b		0.44	0.5		0.01
Niacin (mg)	3.1 ^b		7.5	8		0.5
Pantothenic acid (mg)	0.3 ^b		0.43	0.7		Tr
Vitamin B ₆ (µg)	0.17 ^b		0.1	0.1		0.02
Folacin (µg)	34 ^b		17.5	30		4
Vitamin B ₁₂ (µg)	0 ^b		0	0.4		0
Vitamin A (iu)	0 ^b		0	61		0
Cholesterol (mg)	0 ^b		0	94		0

^a All information per 100 g product.

Sources: ^b Holland *et al.* (1991); ^c UK retail packs.

All other data: USDA (1989).

Tr = trace