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DSM Nutritional Products

**CONTEXT**

This translation first published by Context Publications

Context Products Ltd, 53 Mill Street, Packington, Leicestershire, LE65 1WN United Kingdom • [www.contextbookshop.com](http://www.contextbookshop.com)

Second edition, 2021. First published 2017

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Technical editing of English translation and proof-reading by: Jonathan Steffen Ltd, Cambridge, UK • [www.jonathansteffenlimited.com](http://www.jonathansteffenlimited.com)

Design and artwork by Mono Design Ltd • [www.monodesign.co.uk](http://www.monodesign.co.uk)

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British Library Cataloguing in Publication Data

The Illustrated Egg Handbook

Author: Ayuko Kashimori

ISBN 9781899043859

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# A message from the author

It is well known that eggs are a natural and nutritious food source. What is less well known is the fact that, as a natural product, no two eggs are ever quite the same. Eggs will show variations in shape, color, yolk, size, as well as other characteristics. These can be influenced by the hen's breed and age, by its feed, and by the climate in which it lives. Furthermore, the quality of each individual egg changes over time. On account of these variations, the subjective evaluation of eggs will vary from person to person. It is the purpose of this book to provide a graphic guide to the wide range of possible egg characteristics and their potential causes, and to provide recommendations for their usage. Our company, NABEL Co.,Ltd., has developed egg detectors for various egg abnormalities such as shell cracks, dirtiness, blood spots or rottenness. These and more examples have been collected in the course of our technical journey, and were first published in a book that appeared in Japanese in 2009.

Currently, the Japanese edition of this book is utilized as a communication tool aimed at engendering common perceptions among egg producers, retailers, and consumers. We are very pleased that it is also used as an educational tool for new employees, as well as high school and university students.

Encouraged by the successful reception of the Japanese edition, we published an English version in 2016. For this we were delighted to engage DSM Nutritional Products as our partner to help us not only to translate the text but also to give it a global focus and approach, without losing its Japanese roots.

Five years have passed since then, and we are now publishing this revised edition, which includes new egg cases, additional scientific findings, and the topic of the United Nations Sustainable Development Goals (SDGs) from the perspective of the food business.

In today's fast-paced, information-driven world, we cannot say that the knowledge incorporated in this

revised edition will be sufficient to address all the questions that future readers might have, but we believe that we have included the content necessary for the correct evaluation of egg quality at this point in time.

We hope that this book will help people to correctly understand the value of eggs, which are a treasure-trove of high-quality proteins and vitamins, to further improve the quality of eggs, and to eat eggs without prejudice.

Finally, I would like to take this opportunity to express my gratitude to DSM for their technical advice, to the scientists who provided the latest knowledge, and to all those who helped with the translation and editing of the revised edition..

**Ayuko Kashimori**  
NABEL Co.,Ltd.  
November 2021



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## Chapter 1

# Basic egg knowledge

This chapter introduces the basic properties of eggs, along with important background information that will help the reader make effective use of this handbook.

1

# The structure of an egg

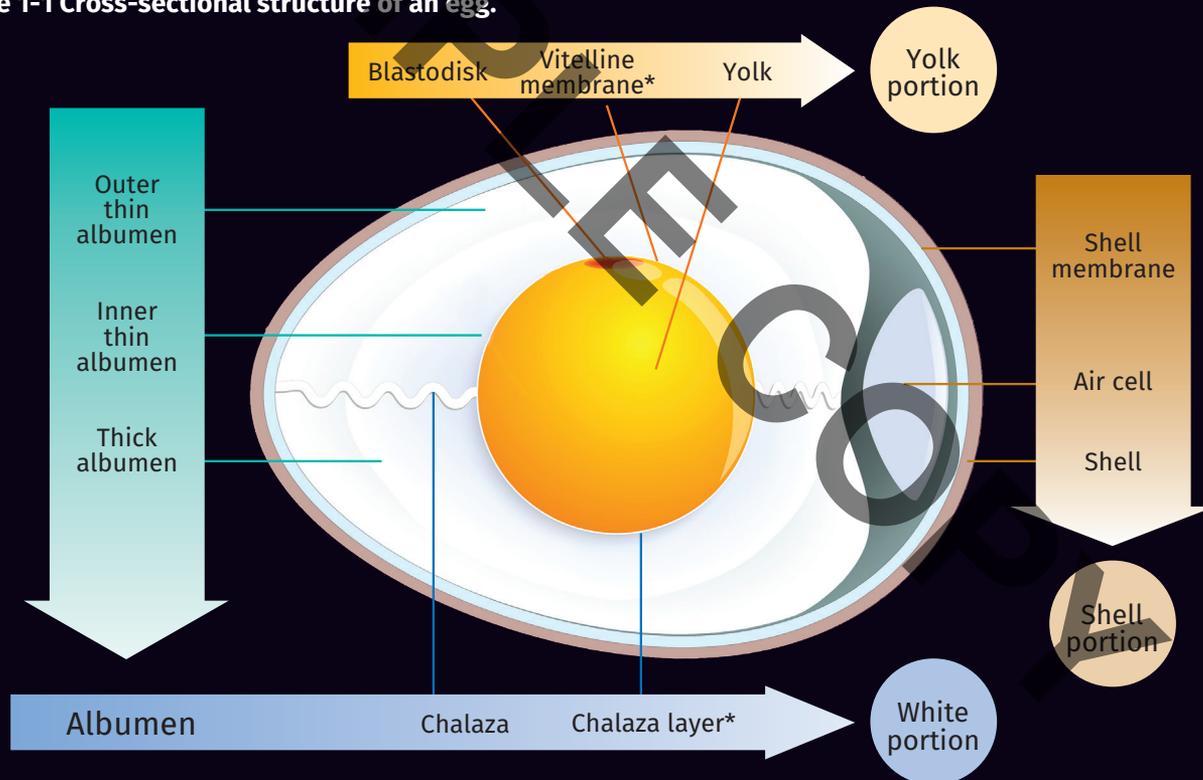
Bird eggs exhibit an exceptional tissue structure that serves to prevent physical damage and contamination with microbes from outside the egg. In a fertilized egg from an ovulating chicken, this structure protects the embryo over the approximately three weeks that it takes for the egg to hatch.

Broadly speaking, shell eggs consist of three areas, from the outside in: the shell portion (which includes the shell, shell membrane, and air cell); the white portion (which includes the albumen, chalaza, and

chalaza layer); and the yolk portion (which includes the vitelline membrane, blastodisc, and yolk). These areas of the egg exist in a ratio of approximately 1:6:3 by weight.

Figures 1-1 and 1-2 show the roles played by the constituent parts of a typical egg.

**Figure 1-1 Cross-sectional structure of an egg.**



\*The chalaza layer is found outside the vitelline membrane.

## Chapter 2

# Examples of eggshells

This chapter introduces abnormalities known to affect the shell and outward appearance of eggs, along with examples of complaints and questions received from consumers.

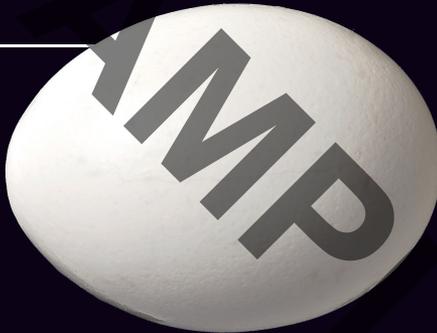


# Minor shell breakage

Hairline cracks become evident with the passage of time. In addition to being visualized by candling and applying pressure along the crack, such defects can be detected by means of sound, since cracked eggs emit a low, dull sound if you tap them near a crack, for example with the tip of a fingernail. Cracks that spread out in a spider web-like radial pattern from the point of an impact are usually seen near the equator of the egg.

(1)

A hairline crack in the shape of a horizontal line exists at the equator of this egg's shell but cannot be discerned with the naked eye.



(2)

When egg (1) is candled, the crack can be clearly discerned.



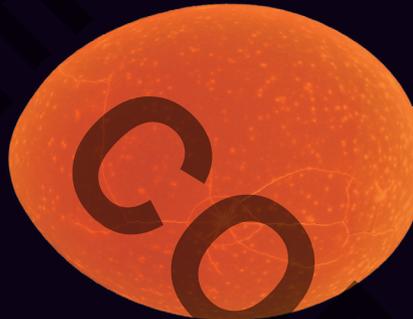
(3)

A spider web-shaped crack has developed at the equator of this egg. Since most of the shell in that area has not collapsed.



(4)

When egg (3) is candled, the crack is clearly discernible.



(5)

The shell of the egg has collapsed around this spider web-shaped crack. It is more visible than egg (3) and can be clearly discerned with the naked eye.

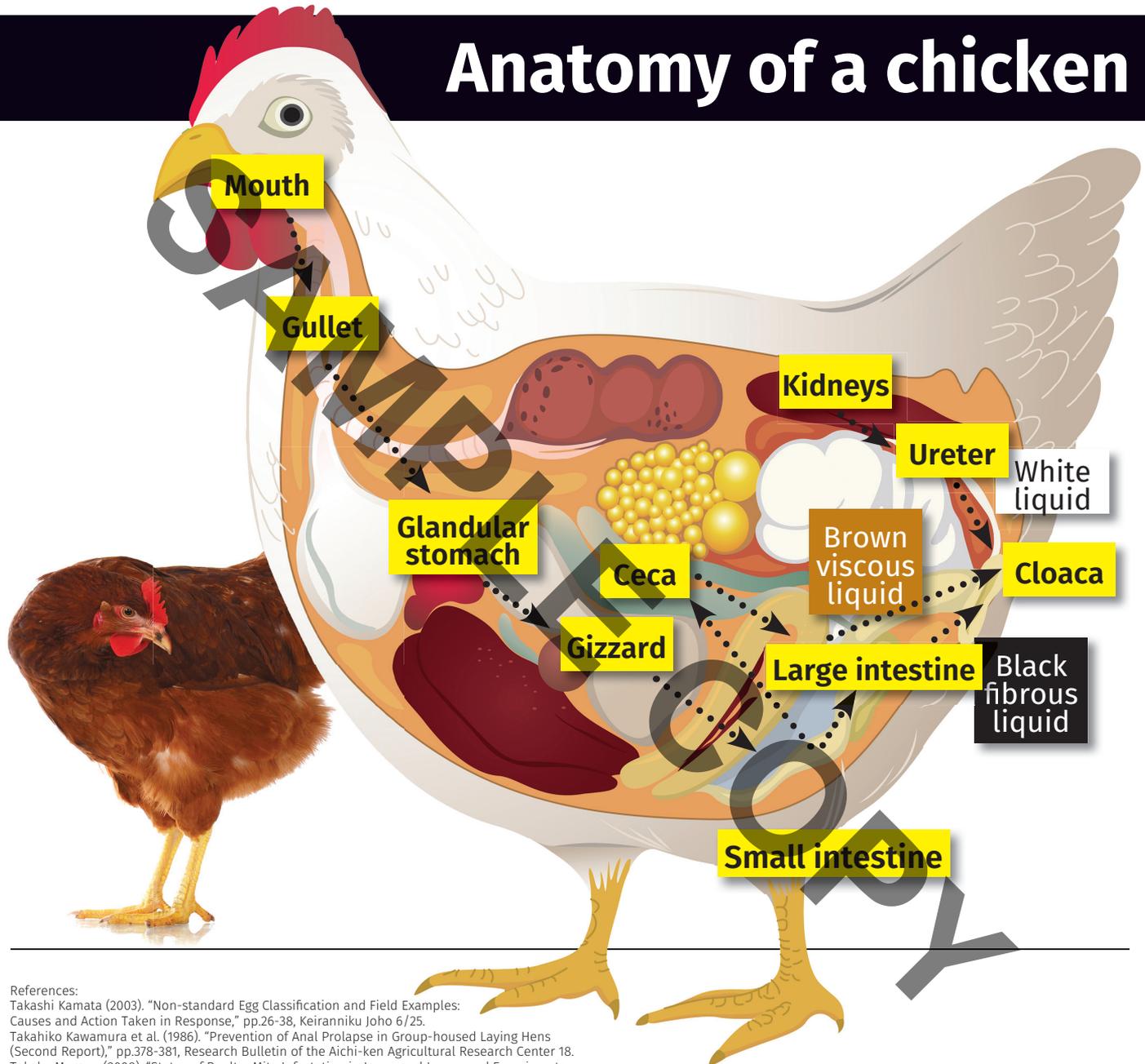


(6)

There is cracking almost all the way around this shell. This defect is often seen in eggs whose quality has been compromised, for example in thin-shelled eggs.



# Anatomy of a chicken



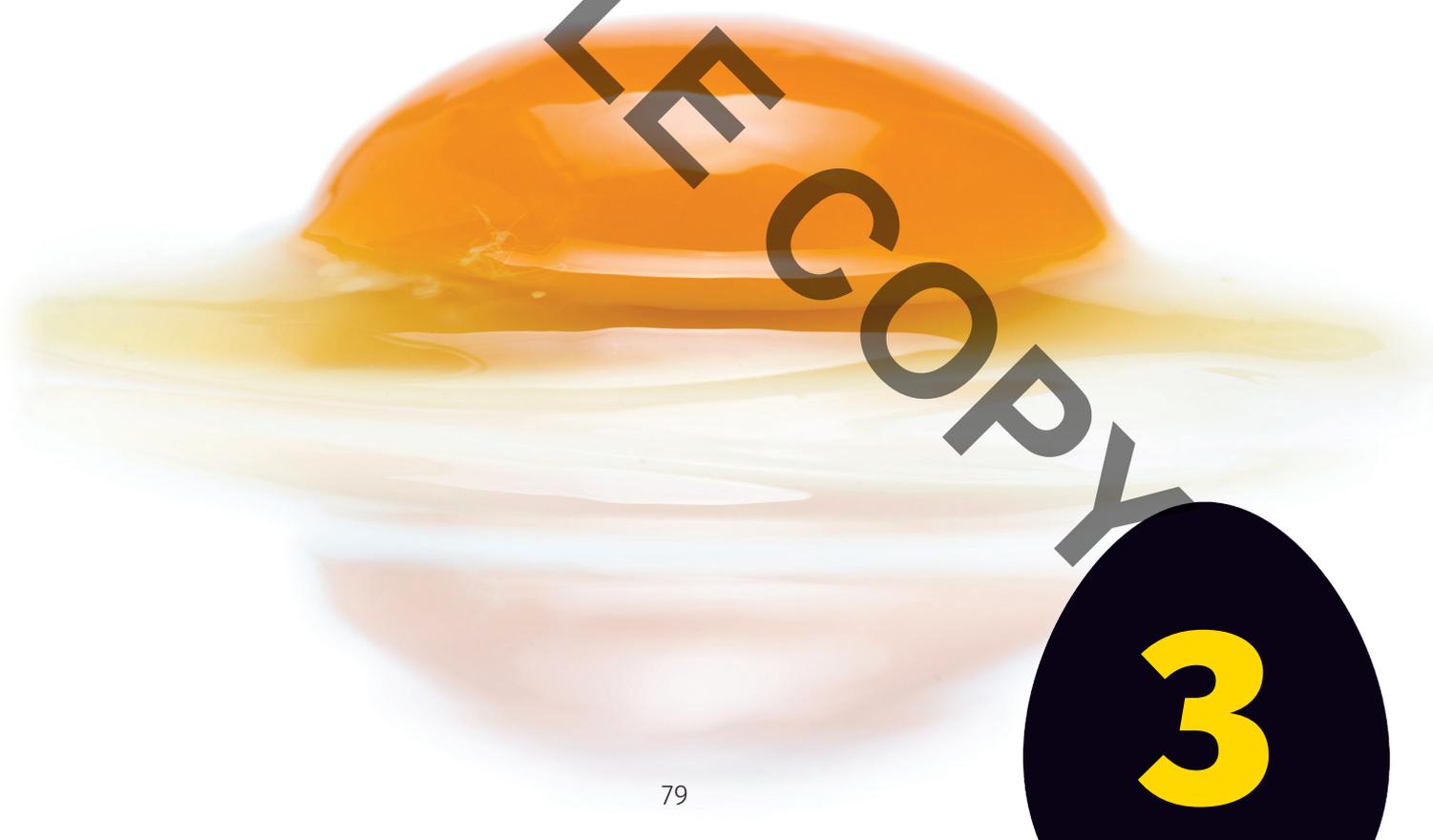
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## Chapter 3

# Albumen and yolk

This chapter focuses on quality problems within the egg itself, highlighting a wide range of abnormalities that can affect the yolk, the albumen and the inside of the shell.



# Eggs with a pale yolk

These eggs have a light, cream-colored yolk. Light yolk color can occur suddenly, resulting from a variety of causes, including use of feed ingredients with low carotenoid content – for example, rice.

This egg has an extremely light-colored yolk for some reason. It scores a 5 on the DSM YolcFan™.

This egg, from the same lot, exhibits a clear difference in yolk color. It scores a 14 on the DSM YolcFan™.

## Background

Chickens cannot synthesize carotenoids in their bodies and instead rely on their feed to supply them. Feed ingredients contain carotenoids such as lutein, zeaxanthin, apo-ester, canthaxanthin, and capsanthin/capsorbin. Causes of light egg color include reduction in carotenoid content in raw materials such as corn during storage and reduction in the ability of aging hens to store the pigments that create yolk color. In addition, hens may lose their ability to absorb feed due to an infection of their small or large intestine with a parasite, causing the color of the yolks in the eggs they produce to approach white. When a large amount of rice or wheat, which contains few carotenoids, is given to hens, the yolk color of their eggs naturally becomes light. Yolk color reflects the amount of carotenoids that were absorbed by the hen and is not affected by the feed's nutritional value. However, only a healthy hen can produce an egg with a golden/orange yolk color.

References: Yoshihisa Yamagami (2008). "Yolk Whiteness and Mottling," pp.42-43, The Yokeinotomo, Vol. 9 2008.  
Kosuke Okada (2007). "Parasitic Infection and Yolk Whiteness," pp.30-34, The Yokeinotomo, Vol. 1 2007.

## Handling precautions

Eggs with light-colored yolks may be eaten as long as the inside is not contaminated or rotten. When a batch of eggs contains one or more eggs with light-colored yolks, their product value as shell eggs may suffer.

## Chapter 4

# Examples of boiled eggs

This chapter introduces abnormalities that are seen in boiled eggs, along with examples of complaints and questions received from consumers.



4

# Boiled eggs with green yolks

The yolks of these boiled eggs exhibit color ranging from dark green to black. The discoloration occurs at the surface layer where the yolk and albumen meet but does not extend into the center of the yolk. The yolk will often emit sulfurous odor.

(1)

Left: The yolk of this egg, which was boiled for 30 minutes, has turned green.

Right: The yolk of an egg that was cooled rapidly after being boiled for 12 minutes.



(2)

A cross-section of a yolk that has turned green.

The discoloration can be seen to affect only the surface of the yolk.



## Background

Green discoloration of the surface of the yolk is caused when sulfur (S) contained in the albumen and iron (Fe) in the yolk combine to form ferrous sulfide (FeS) where the albumen and yolk meet. The coloring becomes more pronounced the older the egg and the higher the cooking temperature, and it can be prevented by rapidly cooling the egg with cold water immediately after cooking, which has the effect of lowering the pressure in the shell. Carotenoids seem to improve the vitelline membrane strength and reduce the green discoloration of the yolk.

## Handling precautions

Eggs with green yolks may be eaten without any problem, since the phenomenon presents no hygienic or safety issues.

## Chapter 5

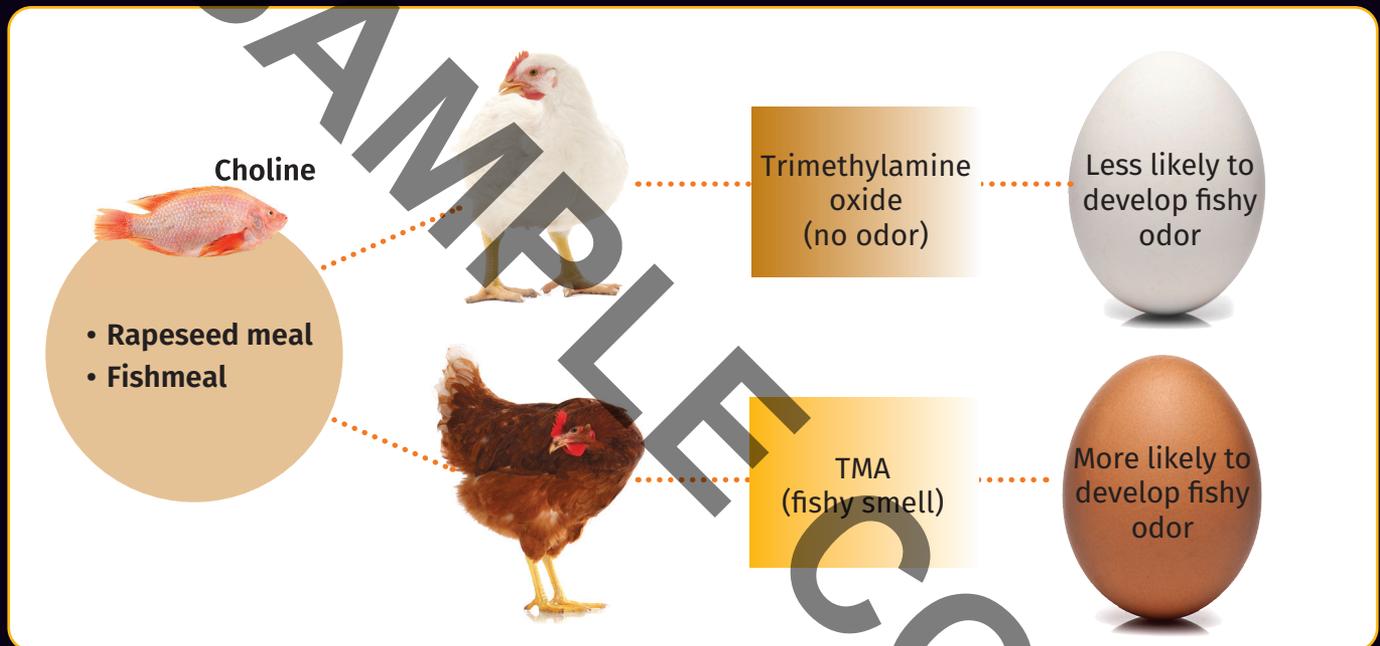
# Examples involving odor

This chapter introduces examples of complaints and questions received from consumers involving the flavor and odor of raw and boiled eggs.



# Fishy odor

Eggs in various states of preparation – including raw eggs broken open, eggs in the process of being cooked, and boiled eggs may give off a fishy odor. Although it is extremely rare, eggs giving off a very strong odor may be distinguished by the odor emitted from the shells. Some people perceive a faint fishy odor as being just an egg-like aroma, and people tend to have strong opinions about whether they like or dislike this odor.



## Background

It is thought that the fishy odor given off by some brown eggs derives primarily from trimethylamine (TMA). Since brown layers have lower TMA oxidase activity in their livers than white layers, they synthesize TMA in their bodies from fishmeal and rapeseed meal in their feed. It is known that when the concentration of TMA exceeds a certain amount, these hens' eggs give off a fishy smell.

Apart from feed, TMA may be given off by the rotting process in liquid eggs.

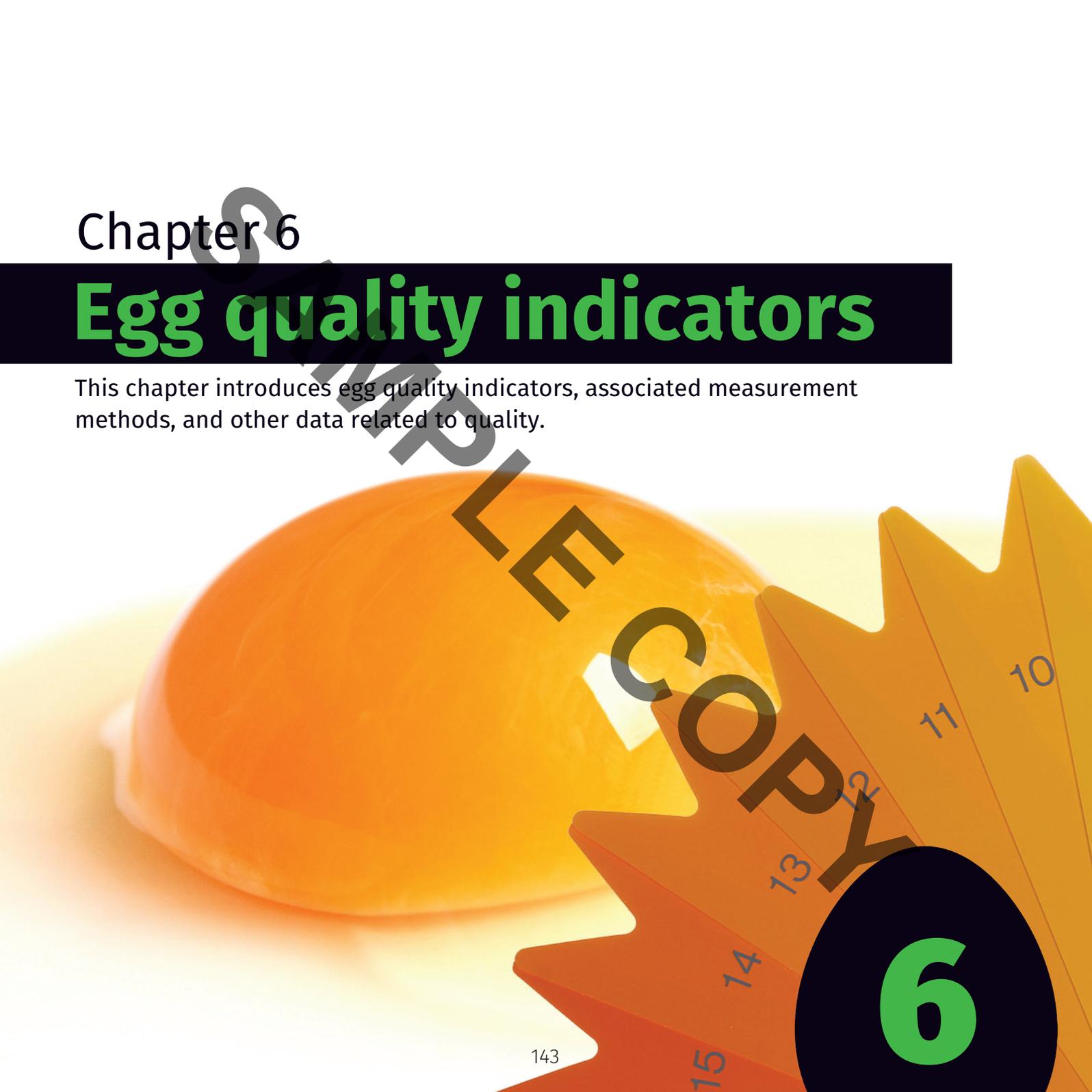
## Handling precautions

Eggs may be eaten as long as the inside is not contaminated or rotten. Although odor does not reflect any issue with the egg's internal quality, eggs that give off a fishy odor may be perceived as having lower product value as shell eggs if the odor is very strong or if consumers dislike even slight amounts of odor.

## Chapter 6

# Egg quality indicators

This chapter introduces egg quality indicators, associated measurement methods, and other data related to quality.



6

# Classifying egg quality (Japan)

The *Egg Standard Transaction Guidelines* (issued as a bulletin by the Administrative Vice-minister of Agriculture, Forestry and Fisheries on December 1, 2000) sets forth a series of standards, called the Egg Transaction Standards, governing egg transactions for shelled and other eggs, including weight categories, labeling methods,

and container materials (see “Egg Transaction Standards (Boxed Egg Standards)” on page 157). Similarly, the *Guidelines on Sanitary Management at Egg Grading and Packing Facilities* (issued as Bulletin No. 1674 by the Director-General of the Environmental Health Bureau of the Ministry of Health and Welfare on November 25, 1998) sets forth a

series of implementation guidelines for such aspects of industry operations as the storage, washing, packaging, and labeling of shell eggs. This section introduces an overview of those portions of both sets of guidelines that relate to the classification of the quality of shell eggs as outlined in Tables 6-1 and 6-2.

**Table 6-1. Overview of quality classifications defined by the Egg Transaction Standards.**

Grade		For raw consumption		For cooked consumption	Not for consumption
		Special Grade	Grade 1	Grade 2	Not classified
Shell (appearance inspections, candling)	Shape	Oval	Somewhat distorted	Oddly shaped	Moldy Broken eggs with leakage of egg contents Accompanied by unpleasant odor
	Texture	Fine	Somewhat rough	Very rough Soft shell	
	Color	Normal color	Somewhat faded		
	Presence of dirt	Clean	Minor dirt	Significant dirt	
	Damage	No damage	No damage	Broken but without leakage of egg contents	
Egg contents (Candling)	Yolk	Located in center	Somewhat offset from center Somewhat flattened	Significantly offset from center Flattened and enlarged Scrambled yolk and white (mechanical cause)	Rotten Interrupted incubation Contaminated with blood Scrambled yolk and white (mixed rot) Contamination with foreign matter
	White	Not flaccid	Somewhat flaccid	Flaccid and liquefied	
	Air cell	Depth of 4 mm or less. Uniform	Depth of 8 mm or less. Slight movement	Depth of 8 mm or more Significantly offset	
Egg contents (Inspection after breaking)	Yolk	Round with good height	Somewhat flattened	Flattened with flaccid vitelline membrane	
	White	Mostly thick albumen with good height	Small amount of thick albumen, flattened	Mostly thin albumen that is spread out	





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