The Role of Diet in CANARY COLOUR Part 1

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Figure 1—Roller Canary displaying colouration typical of the original wild-type Atlantic Canary

This two-part article explores the factors affecting canary colouration, with particular emphasis on the role of diet. Part 1 looks at yellow canaries and part 2 will cover red factor birds. Many of the principles discussed also apply to other bird species in aviculture, including finches and softbills.

Canaries are one of the world's most popular cage birds due to a combination of their melodious song and beautiful colour varieties. Domestic canaries are derived from the wild Atlantic Canary Serinus canaria, a native finch from the Canary Islands off north-west Africa. Wild birds are mostly brown to yellowish-green, with darker streaking on the back and sides. Canaries were brought to Europe in the 17th century and were selectively bred to produce birds of fine song. This domestication process also led to the production of colour mutations including clear white, bright yellow to orange and a range of variegations.

COMPONENTS OF CANARY COLOUR

The three components that make up a canary's colour are feather structure, melanin pigments and carotenoid pigments.

Feather Structure

Feathers are made of the structural protein keratin which is formed into barbs, barbules and hooklets in the follicle as the feather develops. In tail and flight feathers these barbules and hooklets link together like Velcro™ that applies strength and shape so the feathers can support flight. When these barbules unlink, birds repair the damage by preening. This structure scatters light and produces different visual effects depending on the pigments incorporated into the feather. Feathers that contain no pigment reflect light back to the observer and appear white.

Melanin Pigments

Melanin pigments are responsible for the darker, brown, grey or black colours. These are incorporated into the feathers as background colour and are manufactured in the bird's body.

Carotenoid Pigments

Carotenoid pigments are responsible for the bright yellow, orange and red colours. These are derived only from the diet and are dependent on the types of food eaten and how they are metabolised in the body.

The mixture of feather structure, dark melanin pigments and bright carotenoids give the range of colour and variegations that we see in the various breeds today. In the wild-type canary the darker streaking on the back is mostly melanin, whereas the greenish-yellow is a mixture of yellow carotenoids mixed with a melanin background colour (figure 1).

GENETICS AND DIET

In order to affect a bird's overall appearance, breeders have to consider both genetics and diet. In captivity the genetics are largely controlled by breeders selecting for specific traits such as size, shape and colour. A pure yellow canary has a genetic trait that means the darker melanin pigments have been blocked by generations of selective breeding. Without the melanin background colour, we simply see the result of the bright yellow carotenoid—a pure 'canary yellow' (see figure 3). However, since the yellow carotenoid is derived from the diet, this must also be present in the bird's food in sufficient quantities for the colour to be displayed. Studies on yellow canaries have shown that if you completely eliminate carotenoids from the diet, the birds will fade to white after moulting.

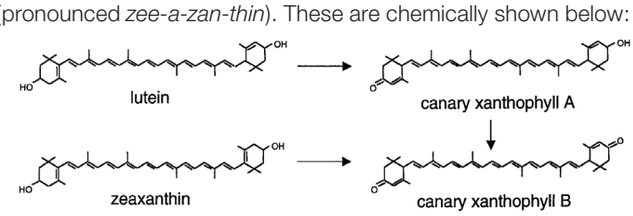
Figure 2—Canaries come in a range of different colours and varieties depending on genetic traits and the birds' diet. Ultimately breeders can manipulate both these parameters

DIET

Carotenoids

The carotenoid component of canary colour must come from the bird's diet. Carotenoids are a group of naturally occurring chemicals produced by plants, bacteria, algae etc which are absorbed and utilised by higher order organisms such as birds and animals.

Often the carotenoids in a bird's diet are modified in the body to produce different carotenoids that are deposited as coloured pigments in the feathers. The most commonly found carotenoids in the feathers of yellow canaries are called canary xanthophylls (pronounced *zan-tho-fills*). These were first isolated in canaries but have since been found in the plumage of a range of different species. Canary xanthophylls are derived from the two dietary carotenoids *lutein* (pronounced *loo-tee-in*) and *zeaxanthin* (pronounced *zee-a-zan-thin*). These are chemically shown below:



Which Foods to Feed

From the above, we can see that canaries require a dietary source of lutein and, to a lesser extent, zeaxanthin to produce their bright yellow plumage. Because many seeds and plant materials contain one or both of these compounds, it is not difficult to provide a diet suitable for yellow canaries—see Table 1.

Table 1: Carotenoid Content and Types in Food and Plant Items

Food Item	Total Carotenoid Content (mg/kg)	Major Carotenoid Type
Wheat, Oats	2	Lutein
Canary Seed Mix	6	Lutein/Zeaxanthin
Corn	20-25	Zeaxanthin
Spinach, Bok Choy	26-76	Lutein
Algae (dried spirulina)	1000	ß-Carotene/ Zeaxanthin
Marigold Petals	8000	Lutein

Common cereal grains (such as wheat and oats) have low levels of carotenoids, with levels being slightly higher in canary seed mixes. Fresh vegetables (such as corn and carrot) and green leafy vegetables (such as spinach and bok choy) are higher again. Some concentrated foods like spirulina (dried algae extract) have even higher levels, but often the types of carotenoids they contain may not be readily utilised to produce the colour we are seeking (eg ß-carotene has little affect on a yellow canary's colouration). The petals of marigold flowers are one of the highest known naturally occurring sources of lutein and are actually used to commercially extract this substance for use in feed concentrates (figure 4).

It is important to note that the carotenoid content of food decreases with time and exposure to heat, light and air. This also applies to vitamins and minerals and therefore has significant impact on the nutritional value of the foods we offer. Field tests show that dry, old seed has lower carotenoid content than fresh green seed (figure 5). Seed certainly doesn't come with a 'best before' date, so it is always best to feed as much fresh, green food as possible, such as seeding grasses, chickweed, thistles and dandelion—all foods that are likely to contain good levels of carotenoids.

Figure 4—Powdered lutein concentrate extracted from the petals of the marigold flower, utilised in the canary feed trials

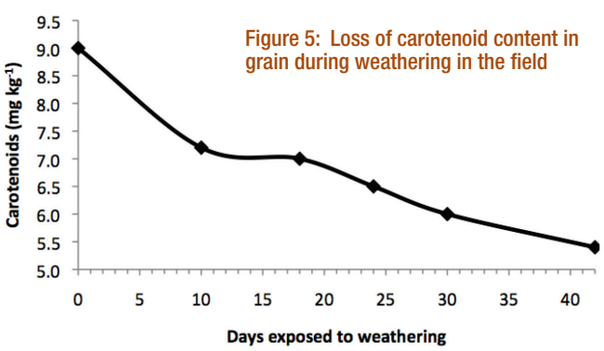


Figure 5: Loss of carotenoid content in grain during weathering in the field

Supplementing the Diet

Canaries need to have a regular supply of the correct carotenoids in their diet in order to produce well-coloured feathers. This is particularly important prior to the moult. Colour is deposited in the growing feather from carotenoids modified in the liver or the feather follicle. Once a new feather is grown, blood supply is cut off to the follicle, and the feather's colour is then fixed. A lack of circulating carotenoids in the blood stream at the time of feather growth will result in poorly coloured plumage which cannot be reversed until the next moult.

We have undertaken feeding trials on yellow canaries to determine the value of supplementing carotenoids into a dry seed diet. We measured carotenoid levels in the seed, the bird's blood plasma and feathers before and after supplementing with lutein and zeaxanthin.

Results of the feed trials showed that treating the seed with lutein and zeaxanthin significantly increased the carotenoid levels circulating in the bird's bloodstream. This more than doubled the carotenoid content of the breast feathers, resulting in consistently brighter plumage compared to birds fed exclusively on a plain seed diet. This provides a useful means of ensuring adequate dietary carotenoids often lacking in the captive diet.

In doing these trials, we developed a unique infusion process to absorb the carotenoids into the seed kernel, ensuring optimum levels of carotenoids are consumed by the bird. This has now been developed in the new Passwell Yellow Factor Canary Seed™, the first commercially available carotenoid-enhanced canary seed mix.

Health Benefits

Providing carotenoids in the diet has many other benefits to birds. Carotenoids act as potent antioxidants and immune system stimulants and therefore improve the health of birds under stress or disease. They are also deposited into the egg yolk and provide ongoing antioxidant protection to developing chicks. Bright colouration due to carotenoid intake is a sign of good health and vitality, so is highly desirable for birds seeking a mate.

Table 2: Carotenoid feed trials with yellow canaries

Diet	Carotenoid Content		
	In the Seed Mix	In the Blood Plasma	In the Breast Feathers
Control (Normal seed mix)	6 mg/kg	23 mg/litre	90 mg/kg
Treatment seed mix with added lutein/zeaxanthin)	56 mg/kg	44 mg/litre	223 mg kg

Source: Brian Rich, Wombaroo/Passwell Food Products.

>> RESOURCES...

Keeping Canaries—see What's New on page xxx. Available from ABK Publications at www.birdkeeper.com.au or Free Mail Order Card.

Figure 3—The yellow canary has been genetically selected to block the darker melanin pigments in the plumage, leaving the bright carotenoid-based yellow colour