

Supporting Information

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1. Method and materials

1.1 Preparation and composition analysis of compound feeds

The feed ingredients are given in Table S1. The protein sources in the feeds are casein and bean pulp, the fat sources are soybean oil and perilla oil, the carbohydrate sources are bean pulp, α -starch, flour and sodium fucoidan, and the binders are α -starch, sodium fucoidan and sodium carboxymethyl cellulose.

The ingredients were mixed well in a blender, the purified water equivalent to 30% of the total weight of the ingredients were added, continued to mix until the flocculent form appeared, poured to a low temperature expanded feed tablet press to make flakes of 1cm x 1cm x 1mm. Dried in a thermostatic oven at 55°C for 12h, cooled down, then stored in -20°C refrigerator under the shaded condition. The feeds were crushed into the size about 0.5cm x 0.5cm x 1mm until the "tailor-made compound feed" was prepared, with the nutritional components.

The ash content in the feeds was determined with reference to the state standard GB5009.4-2016 and the ash content in the specimens was calculated by the equation given below:

$$X = \frac{m_1 - m_2 - m_0}{m_3 - m_2} \times 100$$

Where:

X - the content of ash in the specimen, in %;

m_0 – the mass of magnesium oxide (the product generated from burning of magnesium acetate), in g;

m_1 – the mass of crucible and ash, in g;

m_2 - the mass of crucible, in g;

m_3 - the mass of the crucible and the specimen, in g.

Determination of moisture content in feeds: weighed clean and dry glass dish, put into a 100-105 °C oven for 10 minutes, cooled down to room temperature, weighed as m_0 . Then weighed about 5g of the specimen and transferred to the glass dish, with the gross weight of glass dish and the specimen denoted as m_1 . Placed the dish loaded with specimen in a 100-105°C oven for 2h, cooled down to room temperature, weighed as m_2 . The moisture content was calculated by the equation given below:

$$\text{Moisture content (\%)} = \frac{(m_1 - m_2)}{(m_1 - m_0)} \times 100$$

Where:

m_1 – the mass of the crucible and the specimen, in g;

m_2 - the mass of the crucible and the specimen without moisture, in g;

m_0 – the mass of crucible, in g;

The protein content in feeds was determined with reference to the state standard GB/T6432-2018. The crude protein content was calculated by the equation given below, each specimen was determined three times in parallel and the results were averaged as the measured result.

$$\text{Crude protein content (\%)} = \frac{(V2-V1) \times c \times \frac{14}{1000} \times 6.25}{m \times \frac{V}{V}} \times 100$$

Where:

V2 - the volume of hydrochloric acid standard titration solution consumed for titration of the specimen (mL).

V1 - the volume of hydrochloric acid standard titration solution consumed by the blank titration (mL).

c - the concentration of standard titration solution of hydrochloric acid (mol/L).

m--the mass of the specimen (g).

v - the total volume of the boiling sterilization solution of the specimen (mL).

V – the volume of the boiling sterilization solution for distillation (mL).

14 – the molar mass of nitrogen (g/mol).

6.25 - the average coefficient of nitrogen converted to crude protein.

Table S1. Nutrient composition of regular formulated feed.

Diet	Ash (%)	Moisture (%)	Crude protein (%)	Crude lipid (%)	Crude carbohydrate (%)
Formulated feed	29.10	5.34	36.36	4.54	24.66

Table S2. Feed formula for feeding experiment

Ingredients	Percents in diet (% dry weight)
Casein	18.00
Soybean meal	24.50
α -Amylase	12.00
Flour	14.00
Soybean oil + Perilla seed oil	4.00
Vitamin premix	2.00
Mineral premix	4.00
Sodium alginate	15.00
Choline chloride	0.50
Calcium dihydrogen phosphate	10
Carboxymethyl cellulose	4.20
10% Zeaxanthin	0.36
10% β - Carotene	0.45

*Vitamin premix, each 1000 g of diet contained: vitamin A, 100, 000 IU; vitamin B, 25, 000 IU; vitamin D3, 4000 IU; vitamin K3, 450 mg; vitamin B1, 1000 mg; vitamin B2, 1000 mg; vitamin B3, 800 mg; vitamin B6, 1000 mg; vitamin B12, 5 mg; folic acid, 450 mg; nicotinamide 7000 mg; calcium pantothenate, 3500mg; biotin, 50 mg; inositol, 8000.0 mg; vitamin C, 4000 mg; L-carnitine, 250 mg; 4-Aminobenzoic acid, 400 mg.

*Mineral premix, each 1000g of diet contained: glycine iron chelate 2500 mg; zinc methionine chelates 9000 mg; glycine copper chelate 5000 mg; methionine manganese chelate 30000 mg; Sodium Selenite Calcium Iodate, 75 mg; cobalt sulfate, 400 mg; potassium chloride, 75 mg; magnesium sulphate, 150000 mg; calcium stearate, 60000 mg.

Table S3. Initial specifications of abalone for experiment (mean \pm SD)

Group	Shell length (mm)	Fresh weight (g)	Foot muscle color	Color difference value (a*)
A	38.64 \pm 2.54a	6.32 \pm 1.41a	orange	22.55 \pm 4.31a
B	35.09 \pm 2.60b	4.86 \pm 1.17b	yellow	6.47 \pm 1.83b

*Differences denoted by distinct letters within the same column are statistically significant ($P < 0.05$).

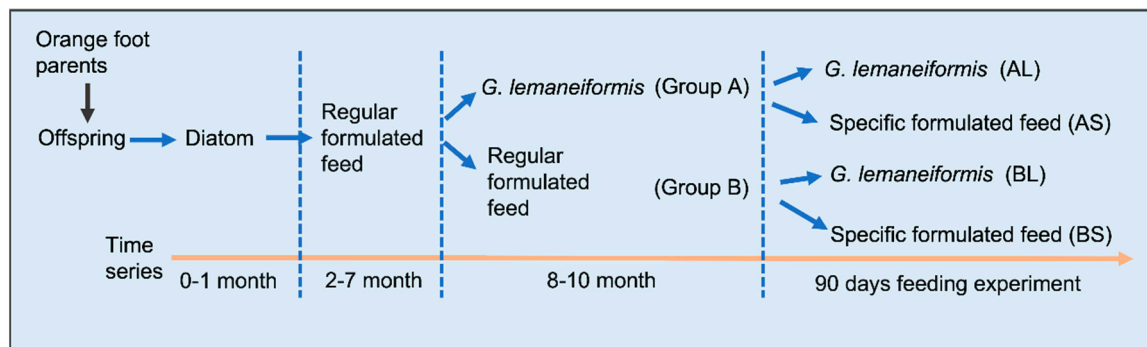


Figure S1. Schematic diagram of the feed experiment grouping. Regular formulated feed do not contain introduced carotenoids, while the specific formulated feed has carotenoids introduced.