OMEGA-3 LONG CHAIN POLYUNSATURATED FATTY ACID (n-3 LCPUFA) LEVELS IN CHICKEN PRODUCTS FOLLOWING CONSUMPTION OF ALPHA-LINOLENIC ACID ENRICHED DIETS

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ABSTRACT

The importance of dietary omega-3 long chain polyunsaturated fatty acids (n-3 LCPUFAs) in human health has promoted interest in developing a range of n-3 rich foods. The inclusion of n-3 FA into chicken products can be achieved by feeding chickens marine n-3 LCPUFA sources such as fish oil. However, this dietary approach has proven problematic due to impaired sensory qualities in the chicken products. The inclusion of the plant n-3 PUFA source alpha-linolenic acid (ALA, 18:3n-3), the n-3 LCPUFA precursor, into the diet of chickens is potentially an alternative way to provide chicken products rich in n-3 LCPUFAs without these detrimental sensory effects.

The objectives of the study were to investigate whether including ALA in the diets of two strains of laying hens and two strains of broilers would increase n-3 LCPUFA accumulation in eggs and meat, without altering production performance or the sensory characteristics of the products. The levels of dietary ALA tested in both laying hen and broiler experiment were 0.3 (low), 3 (moderate) and 6% energy (high; %en), while holding the level of LA constant at around 4%en in the moderate and high ALA diets.

The findings in this study demonstrated that independent of strain, for both eggs and meat, the level of EPA was directly related to the level of ALA in the diet. On the other hand the longer chain fatty acids, DPA and DHA, tended to reach maximal levels when the level of dietary ALA reached 3%en. The level of total n-3 fatty acids

in products from chickens fed ALA enriched diets (3 or 6%en for laying hens and 6%en for broilers) met the requirement needed for labelling as egg and meat n-3 PUFA sources (300mg/egg or 300mg/100g of meat). Fatty acid analysis of lipid fractions in breast meat showed that while ALA was mainly associated with triglyceride (TG) fraction, the n-3 LCPUFA were preferentially deposited in the phospholipids (PL). There was strain dependence in the ability of the chickens to convert ALA into n-3 LCPUFA. Among layers, brown hens were found to be more effective in converting ALA to n-3 LCPUFA than white hens, whereas in broilers, Cobb birds were more effective in the accumulation of n-3 LCPUFA than Ross birds.

Dietary ALA enrichment up to a level of 6%en did not influence the sensory quality of boiled eggs whereas in scrambled eggs, high ALA diets tended to decrease egg aroma. Importantly, a diet enriched with 3%en ALA did not change the consumer acceptance of the eggs compared with eggs purchased from a local supermarket. In broilers, a diet containing ALA 3%en did not affect any of the sensory attributes tested. Importantly, the sensory quality of chicken breast meat from birds fed a dietary ALA of 3%en was comparable to that of commercial breast meat purchased from a local supermarket. There were strain effects on the sensory attributes of the eggs, with boiled brown eggs having a significantly ($P < 0.05$) stronger after-taste than boiled white eggs whereas white eggs had a stronger ($P < 0.05$) sulphur flavour than brown eggs. In scrambled eggs, stronger egg aroma, sulphur flavour, and butter flavour were detected in brown eggs ($P < 0.05$) than white eggs.

In conclusion, a dietary ALA level of approximately 3%en could be recommended as a good ALA level for producing eggs and chicken meat n-3 LCPUFA by industry. The findings of this study demonstrated that incorporating n-3 rich vegetable oils into chicken diets could be an alternative to marine sources to produce eggs and meat higher in n-3 LCPUFA, without influencing either production performance of birds or sensory qualities of the chicken products. This strategy would help to provide consumers with a variety of foods rich in n-3 LCPUFA, and help to achieve recommended intakes for human health.

DECLARATION

This is to certify that the data contained in this thesis is my own work and this work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution to Lilik Retna Kartikasari and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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Publications:

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ABBREVIATIONS

AA	Arachidonic acid (20:4n-6)
ALA	Alpha (α)-linolenic acid (18:3n-3)
ANOVA	Analysis of variance
BHA	Butylated hydroxyanisol
CHD	Coronary Heart Disease
CVD	Cardiovascular diseases
DHA	Docosahexaenoic acid (22:6n-3)
DPA	Docosapentaenoic acid (22:5n-3)
EFA	Essential fatty acid
EPA	Eicosapentaenoic acid (20:5n-3)
FAME	Fatty acid methyl ester
GC	Gas chromatograph
GLA	γ-linolenic acid
H	Hydrogen
H_2SO_4	Sulphuric acid
ISSFAL	International Society for the Study of Fatty Acids and Lipids
LA	Linoleic acid (18:2n-6)
MUFA	Monounsaturated fatty acid
NS	Not significant
n-3	Omega 3
n-6	Omega 6
n-9	Omega 9
Na_2SO_4	Sodium sulphate
NHMRC	National Health and Medical Research Centre
NNS	National Nutrition Survey
LCPUFA	Long chain polyunsaturated fatty acid
PL	Phospholipids
PUFA	Polyunsaturated fatty acid
SARDI	South Australia Research and Development Institute

SDA	Stearidonic acid
SFA	Saturated fatty acid
TL	Total lipid
TG	Triglycerides
TLC	Thin layer chromatography
UV	Ultraviolet

UNITS

°C	Celcius
cm	Centimetre
d	Day
et al.	and others
g	Gram
h	Hour
kg	Kilogram
L	Litre
mg	Milligram
mL	Millilitre
m^2	Square metre
µ	Micro
v/v	Volume by volume