

### OMEGA-3 ENRICHMENT OF CHICKEN MEAT FOLLOWING THE CONSUMPTION OF OMEGA-3 RICH VEGETABLE OILS

Lilik Retna Kartikasari

Supervisors: Prof. Robert A Gibson Dr. Bob Hughes



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## Summary of the health benefits of n-3 LCPUFA

- Reduce heart disease (Nordoy et al, 2001)
- Prevent rheumatoid arthritis (Cleland and James, 2002)
- Prevent cancer (Bourre and Galea, 2006)
- Improve the development of neural and visual functions in infants (Lauritzen et al., 2004; Makrides et al. 2009)



- Omega-3 LCPUFA (20 and 22 carbons, EPA, DPA and DHA):
  - 650 mg/day
- Omega-3 PUFA (18 carbons, ALA):
  - 1.5 to 3 g/day
- Current Australian intake: ~250 mg/d omega-3 LCPUFA and 1.2g/d ALA

## **One strategy to increase n-3 LCPUFA in chicken meat: Add fish oil to chicken diets**

- A diet enriched with fish oil increased the amount of omega-3 LCPUFA, EPA and DHA in chicken meat (Bou et al., 2005; Chekani-Azar et al., 2008).
- Problems:
  - Negative effects on the sensory properties of meat
  - Containing highly toxic chemicals (methyl mercury)

## Another strategy; Feed ALA from vegetable oils so that chickens convert to n-3 LCPUFA

- Several studies have tested feeding diets rich in ALA to increased tissue ALA content
- Most studies failed to demonstrate a large increase in EPA, DPA and DHA in tissues
- Could be due to competition between the omega-6 and omega-3 fatty acids in the pathway

(Gonzalez-Esquerra et al., 2000; Bou et al., 2005)





## **Project Aims:**

To examine the effect of ALA content of diets on the conversion and accumulation of EPA, DPA and DHA into chicken tissues.



## Methodology

- Seventy unsexed 1-day old chicks (Cobb) were randomly allocated in seven pens and assigned to either a control diet or six experimental diets.
- Chickens were fed with experimental diets prepared from basal diet, and fat sources in the basal diet were supplemented with blended vegetable oils.
- Different fat blends were obtained by varying the proportion of different vegetable oils

## DIETS

Diets contained an increasing proportion of energy (%en) as ALA while keeping the level of LA relatively constant



## Methodology











## Fatty acid analysis



The bottom chloroform layer was evaporated and spotted onto TLC plate

#### Chromatogram of tissue samples









## **Statistical analysis**

A one way ANOVA was used to examine the effect on EPA and DHA concentrations, and the analysis was followed by the tukey test if there were significant differences (P<0.05) between dietary treatments.



## **RESULTS: Omega-3 LCPUFA in plasma and liver**

#### **Plasma PL**

Liver PL



Effects of increasing levels of dietary ALA on omega-3 LCPUFA of plasma and liver tissues. Omega-3 LCPUFAs increased (P<0.001). The values presented are means of six replicate analyses  $\pm$  SEM



# Chickens respond differently to dietary ALA than rats

#### **Chicken Plasma**





Changes in plasma DHA in chickens does not show the complex relationship to dietary ALA as seen in rats. Reasons are unclear.



## **Omega-3 LCPUFA in breast and thigh meat**

#### **Breast PL**



ALA (% en) of diets

#### Thigh PL



Effects of increasing levels of dietary ALA on omega-3 LCPUFA of breast and thigh tissues. Omega-3 LCPUFAs increased (P<0.001). The values presented are means of six replicate analyses  $\pm$  SEM



## How our results compare with other studies



LA to ALA ratio of diets

LA to ALA ratio of diets

## How does meat from chickens fed high ALA diets compare with fish?

n-3 LCPUFA sources	EPA	DPA	DHA	Total n-3
	% of total fatty acids			
Breast (old diet)	0.7	1	1	3
Breast (new diet)	4	7	4	17
Australian Whiting	11	4	14	29

The omega-3 LCPUFA levels of meat from chickens fed diets high in ALA contain about 60% of the levels found in Australian Whiting.



## Growth

## There was no effect on weight gain by any of the diets





## **Results summary**

- The increase in ALA content of diets increased the proportion of ALA, EPA, DPA and DHA in breast and thigh
- The highest ALA content (the lowest LA:ALA ratio) resulted in the highest total n-3 and PUFA
- Omega-3 LCPUFA levels reached 60% of the level seen in Australian whiting
- There was no significant effect of diets on the growth of birds.



## CONCLUSIONS

- The accumulation of omega-3 LCPUFA in chicken tissues is directly related to ALA content in the diets
- There was no maximum level achieved for tissue EPA, DPA and DHA which suggests that there are different control mechanisms in the chicken than in the rat for LCPUFA synthesis
- Increasing the ALA content of feeds for broilers may be a useful strategy for increasing the omega-3 intakes of Australians



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# When omega-3 LCPUFAs go up, what comes down ?



Effects of increasing levels of dietary ALA on the balance of omega-3, omega-6 and monounsaturates in chicken breast tissues.

# Some omega-3 LCPUFA replace specific omega-6 LCPUFA

#### **Breast PL**

**Thigh PL** 



Effects of increasing levels of dietary ALA on arachidonic acid (AA) of breast and thigh tissues. AA decreased (P<0.001). The values presented are means of six replicate analyses ± SEM