UNIVERSITI PUTRA MALAYSIA

EFFECTS OF DIETARY FATTY ACID SATURATION ON BROHLER CHICKENS SUBJECTED TO HIGH AMBIENT TEMPERATURES

NWE NWE HTIN.

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By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of Requirements for the Degree of Doctor of Philosophy

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Dedicated to my beloved parents, devoted husband and dearest only one son

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

EFFECTS OF DIETARY FATTY ACID SATURATION ON BROILER CHICKENS SUBJECTED TO HIGH AMBIENT TEMPERATURES

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Chairman: Professor Zulkifli Idrus, PhD

Faculty: Agriculture

The effects of dietary fat with various fatty acid saturations on physiological response, performance, carcass fatty acid deposition, and immune response and disease resistance in heat stressed broiler chicks were studied. Day old male broilers chicks (Cobb) were brooded and consequently maintained at 24 ± 1°C in an environmentally controlled house. All the chicks were fed a starter ration without added fat. On day 21 onwards, equal numbers of chicks were provided isocaloric and isonitrogenous finisher diets containing different oil sources namely 8% menhaden fish oil (FO), 8% soybean oil (SO), 8% coconut oil (CO), 8% palm oil (PO) or no added fat (control). From day 28 to 41, all birds were exposed to 36 ± 1°C for 2 h/day. Following 14 days of the heat challenge, the PO birds had greater body weights than the other three groups. The control and PO birds were less hyperthermic and had smaller increases in heterophil/lymphocyte ratio than those provided FO, SO and CO diets. Although the mortality rate of PO birds was higher than the control, it was lower than their

FO, SO and CO counterparts. Diets rich in saturated fatty acids (CO) increased abdominal fat and crude fat per cent of thigh meat as compared to diets rich in polyunsaturated fatty acids (SO and FO). Tissue fatty acid deposition was significantly different according to dietary oil sources, specific to tissue type, fatty acid structure, and the amount of deposition was not proportional to its intake. Broilers fed 8% fish oil showed higher concentration of long-chain n-3 PUFA (EPA and DHA) in the meat tissue than other counterparts. High inclusion levels of dietary PUFA could provide the recommended polyunsaturated to saturated fatty acid ratio in meat tissue of broilers under high ambient temperatures.

Broiler chicks (Cobb) were used to study dietary self-selection of fat under high ambient temperatures. Commencing from day 21, chicks were assigned to one of four dietary treatments: (1) diet with 8% palm oil (PO); (2) diet with 8% soybean oil (SO); (3) diet without added fat (control); and (4) a choice of PO, SO and control (CH). From day 28 to 41, all birds were exposed to 34 ± 1°C continuously. High addition of palm oil but not soybean oil improved survivability and reduced serum creatine kinase levels of broiler chickens during heat exposure. On day 41, the body weights of PO, SO and CH birds were greater than controls. Although the intake of control, PO and SO diets was similar during heat exposure, the CH birds had a lower creatine kinase activity and mortality rate than those provided SO diet but not significantly different from those fed control and PO diets. It was concluded that a high addition of palm oil but not soybean oil is beneficial to heat-stressed broiler chickens. Self-

selection of high fat diet can allow birds to match their physiological requirement under heat stress conditions.

The effects of dietary α-linolenic and linoleic fatty acid on disease resistance and immune response of heat-stressed broiler chicks (Cobb) were investigated. From day 21 onwards, broiler chicks were fed isocaloric and isonitrogenous finisher diets containing either 8% palm oil (neither rich in linolenic or linoleic acid), 8% soybean oil (rich in linoleic acid) and 8% flaxseed oil (rich in linolenic acid). All birds were vaccinated against Newcastle disease on day 7 and 21. From day 36 to 50, equal numbers of birds from each dietary group were exposed to 38 ± 1°C and 80% relative humidity for 2 h/day. The remaining birds were maintained under 24 ± 1°C. Feed and water were not provided throughout the heat challenge period. On day 37, all chicks were intranasally challenged with an infectious bursal disease vaccine, V877 strain (Malaysia Vaccine and Pharmaceuticals Sdn Bhd, Kuala Lumpur, Malaysia). Bursal samples were taken for histopathological examination, determination of viral RNA and fatty acid analysis. Significantly less viral replications were detected in both heated and non-heated broiler chicks fed diet containing 8% flaxseed oil on day 7 post infection. Broiler chicks fed 8% palm oil showed significantly higher viral replications on day 7 post infection under both lower and higher ambient temperatures. Mortality, heterophil/lymphocyte ratio, antibody production and bursal lesion scores were not significantly affected which suggests that palm oil may enhance tolerance to infectious bursal disease under both ambient temperatures.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

KESAN KETEPUAN ASID LEMAK PERMAKANAN KE ATAS AYAM PEDAGING YANG DIKENAKAN SUHU PERSEKITARAN YANG TINGGI

Oleh

NWE NWE HTIN

January 2006

Pengerusi: Profesor Zulkifli Idrus, PhD

Fakulti: Pertanian

Kesan lemak pemakanan dengan berbagai ketepuan asid lemak keatas respon fisiologi, prestasi, pengumpulan asid lemak karkas, dan respon imun dan ketahanan penyakit dalam anak ayam bertekanan haba telah dikaji. Anak ayam (cobb) berumur sehari telah diternak pada suhu 24 ± 1°C dalam rumah persekitaran terkawal. Kesemua anak ayam diberi makanan permulaan tanpa tambahan lemak. Selepas hari ke 21, sebilangan yang sama anak ayam telah diberikan diet rangsum yang isokalorik dan isonitrogenus yang mengandungi sumber minyak yang berbeza iaitu 8% minyak ikan 'menhaden', (FO), 8% minyak kacang soya (SO), 8% minyak kelapa (CO), 8% minyak kelapa sawit (PO) atau tiada tambahan lemak (kawalan). Daripada hari 28 hingga 41, kesemua ayam telah didedahkan kepada 36 ± 1 °C selama 2 jam/hari. Selapas 14 hari cabaran haba, ayam PO mempunyai berat badan yang lebih berbanding tiga kumpulan lain. Ayam kawalan dan PO adalah kurang hypertermik dan

mempunyai peningkatan nisbah heterofil/limfosit yang kecil daripada diberikan oleh rangsum FO, SO dan CO. Walaupun kadar mortality ayam PO lebih tinggi dari kawalan, ia adalah lebih rendah dari FO, SO dan CO. Rangsum yang kaya dalam asid lemak tepu telah meningkatkan lemak abdominal dan peratus lemak kasar daging peha lebih daripada rangsum yang kaya dalam asid lemak poli tak tepu. Pemendapan asid lemak pada tisu adalah berbeza dengan bererti mengikut kepada sumber minyak pemakanan; khusus kepada jenis tisu, struktur asid lemak, dan jumlah pemendapan adalah tidak berkadaran dengan pengambilan makanan. Ayam pedaging yang diberi makan 8% minyak ikan menunjukkan kepekatan n-3 PUFA berantaian panjang (EPA dan DHA) yang lebih tinggi dalam tisu daging berbanding dengan kumpulam. Paras kemasukan PUFA yang tinggi mungkin boleh mencadangkan nisbah asid lemak poli tak tepu kepada asid lemak tepu dalam tisu daging ayam pedaging dibawah suhu persekitaran yang tinggi.

Anak ayam pedaging telah digunakan untuk mengkaji pemilihan sendiri lemak pemakanan dibawah suhu persekitaran yang tinggi. Bermula dari hari ke 21, anak ayam telah diberikan salah satu dari rawatan makanan berikut: (1) rangsum dengan 8% minyak kelapa sawit (PO); (2) rangsum dengan 8% minyak kacang soya (SO); (3) rangsum tanpa tambahan lemak (kawalan); dan (4) pilihan PO, SO dan kawalan (CH). Daripada hari ke 28 hingga 41, kesemua ayam telah didedahkan kepada suhu 34 ± 1 °C secara berterusan. Penambahan minyak kelapa sawit yang tinggi telah memperbaiki kelangsunganhidup dan mengurangkan paras kreatinkinase serum ayam semasa pendedahan haba, tetapi

tidak pada minyak kacang soya. Pada hari ke 41, berat badan ayam PO, SO dan CH adalah lebih berbanding kawalan. Walaupun pengambilan makanan bagi rangsum kawalan, PO dan SO adalah sama semasa pendedahan haba, ayam CH mempunyai aktiviti kreatine kinase dan kadar mortality yang rendah dari ayam yang diberikan rangsum SO tetapi tidak berbeza dengan bererti dengan ayam yang diberi makan rangsum kawalan dan PO. Adalah disimpulkan bahawa penambahan tinggi minyak kelapa sawit tetapi tidak minyak kacang soya adalah bermanfaat kepada ayam pedaging bertekanan haba. Pemilihan sendiri rangsum berlemak tinggi membolehkan ayam menyesuaikan keperluan fisiologi di bawah keadaan tekanan haba.

Kesan asid lemak α-linolenik dan linoleik keatas respon imun ayam pedaging terhadap IBD dibawah tekanan haba dan keadaan termoneutral telah dikaji. Daripada hari 21 keatas, anak ayam pedaging telah diberi makanann pengakhir yang isokalorik dan isonitrogenus mengandungi samada 8% minyak kelapa sawit (PO, samada kaya dalam asid linolenik atau linoleik), 8% minyak kacang soya (SO, kaya dalan asid linoleik) dan 8% minyak biji flax (FXO, kaya dalan asid linolenik) telah disediakan kepada ayam pedaging selapas hari ke 22. Kesemua ayam telah diberi vaksin penyakit Newcastle pada hari ke 7 dan hari ke 21. Profil asid lemak pemakanan telah dianalisa dengan kromatografi gas. Daripada hari ke 36 hingga 50, sebilangan yang sama ayam dari setiap kumpulan rawatan telah didedahkan kepada suhu 38 ± 1 °C dan kelembapan bandingan 80% selama 2 jam/hari. Ayam yang selebihnya diletakkan dalam keadaan termoneutral (24 ± 1 °C). Makanan dan minuman tidak diberikan sepanjang tempoh cabaran haba.

Pada hari ke 37, semua ayam telah dicabar secara intranasal dengan vaksin IBD, strain V877 (Malaysia Vaccine & Pharmaceuticals SDN BHD, Kuala Lumpur, Malaysia). Sampel bursal telah diambil untuk analisa histopatologi, penentuan RNA virus dan analisis asid lemak. Kurang replikasi virus telah dikesan dengan bererti dalam kedua anak ayam yang bertekanan haba dan tidak yang diberi rangsum mengandungi 8% minyak biji flax pada hari ke 7 selepas infeksi. Anak ayam pedaging diberi makan 8% minyak kelapa sawit menunjukkan replikasi virus yang lebih tinggi dengan bererti, pada hari ke 7 selepas infeksi dibawah suhu persekitaran yang rendah dan tinggi. Mortriliti, nisbah heterofil/limfosit, pengeluaran antibody dan skor lesi bursal adalah tidak memberi kesan dengan bererti, ia mencadangkan bahawa minyak kelapa sawit mungkin memperbaiki ketahanan kepada IBD dibawah kedua-dua suhu persekitaran.

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