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# Evaluation of Fatty Acid Composition in Korean Native Chicken Breast Meat

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***ABSTRACT*** This study was conducted to investigate the composition of the fatty acids in the breast meat of Red-brown Korean native chickens (KNC-R). This study used a total sample of three hundred eighty-two KNC-R (males: 190, females: 192). We used the fatty acid methyl ester (FAME) method to extract the fatty acids. A 2-way ANOVA of the R program was used to assess the effects of batch and sex on each fatty acid trait. Analysis of the fatty acid in the sampled population showed that the predominant fatty acid was oleic acid (C18:1; 28.252%) which is monounsaturated fatty acid (MUFA), followed by palmitic acid (C16:0; 20.895%), saturated fatty acid (SFA), and two omega-6 polyunsaturated fatty acid (PUFAs): linoleic (C18:2; 15.975%), and arachidonic (C20:4; 10.541%). Indices used to evaluate the nutritional quality of fat in the diet: ratio between PUFAs and SFAs (P/S), thrombogenicity index (TI), and atherogenicity index (AI) were calculated and were 0.959, 0.814, and 0.355, respectively. Currently, meat consumers need healthier fatty acids. Therefore, information on the content of fatty acid in chicken meat is very important for meat consumers in choosing the type of the meat to be consumed.

(Key words: breast meat, fatty acid composition, Korean native chicken)

## INTRODUCTION

The consumption of poultry meat including chicken meat is globally increasing due to its healthy properties and cheap price compared to other meat types (Munyaneza et al., 2022). The chicken meat contains more protein and less fat (Wang et al., 2023). Chicken meat is a good source of important minerals and vitamins (Marangoni et al., 2015). Even though chicken meat contains less fat compared to red meat types, some of the types of fat such as fatty acids, especially saturated fatty acids have negative health effects (Munyaneza et al., 2019). The SFAs and UFAs are the two groups of fatty acids (Kaić and Mioč, 2016). The MUFAs and PUFAs are two classes of UFAs (Jang and Park, 2020). Fatty acids are sources of energy for the body (Kaić and Mioč, 2016). Moreover, fatty acids such as oleic acid, docosahexaenoic acid (DHA), linoleic acid, and arachidonic acid influence the flavor of the meat (Jayasena et al., 2014; Dinh et al., 2021; Cho et al., 2023).

The composition of fatty acid in chicken meat is predominately made up of oleic acid, palmitic, linoleic, and arachidonic, respectively (Choe et al., 2010; Cho et al., 2023). Generally, saturated fatty acids (SFAs) except stearic acid (C18:0) are known to raise the cholesterol level in the blood leading to heart diseases (Munyaneza et al., 2019; Ding et al., 2022) whereas unsaturated fatty acids (MUFAs and PUFAs) have beneficial effects on cardiovascular health (Frigolet and Gutiérrez-Aguilar, 2017). However, excessive consumption of n‑6 PUFA is not desirable (Pretorius and Schonfeldt, 2021) because it is linked with a high risk of cancer (Xia et al., 2005). By contrast, a higher intake of n−3 PUFA is desirable because n-3 PUFAs decreases the risk for cancers of the breast and colon (Xia et al., 2005). Thus, balancing the content of omega-6 and omega-3 fatty acids prevents coronary heart diseases (Pretorius and Schonfeldt, 2021). Furthermore, it is recommended to reduce SFA intake to 10% of total energy intake for adults and children to reduce the low-density lipoprotein (LDL) cholesterol which is linked with cardiovascular disease (WHO, 2023).

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There are many indices used to evaluate the nutritional quality of fat in the diet including meat but the most common and appropriate indices used are: P/S, AI, and TI (Chen and Liu, 2020). A higher P/S is preferred as it shows a higher content of PUFAs and low content of SFAs. A higher content of PUFAs in diet prevents the development of cardiovascular diseases (CVD). On the other hand, the consumption of diets with lower levels of AI and TI is recommended because the low ratio of AI and TI show a higher content of UFAs and a low content of fatty acid with atherogenic (plaque accumulation in arteries) effects (C12:0, C14:0, and C16:0) and low content of fatty acids with thrombogenic (clots formation within blood vessels) effects (C14:0, C16:0, and C18:0), respectively (Chen and Liu, 2020; Moussavi Javardi et al., 2020; Vázquez-Mosquera et al., 2023).

KNCs are categorized into 5 lines, and KNC-R have more weight and higher content of bioactive compounds compared to other lines (Jung et al., 2013). The breast and thigh meat of the KNC chickens have more content of PUFAs including essential fatty acids compared to broilers (Jayasena et al., 2013).The human body is not able to synthetize two essential fatty acids (linoleic acid and alpha-linolenic acid) and must be obtained from diet (Pretorius B, Schonfeldt, 2021). Linoleic acid is the precursor of n-6 PUFAs such as arachidonic acid (C20:4) (Patterson et al., 2012) while alpha-linolenic acid is a precursor of n-3 PUFAs, including eicosapentaenoic acid and docosahexaenoic acid (Burdge and Calder, 2005; Patterson et al., 2012). Evaluating the composition of the fatty acids in meat is very important as it provides valuable information on the nutritional quality and potential health benefits of the meat. However, studies assessing the content of fatty acids in KNC meat are still scarce.

Thus, the aim of this study was to evaluate the composition of the fatty acid in the breast meat of the Red-brown Korean native chickens (KNC-R).

## MATERIALS AND METHODS

### 1. Ethical Statement

This study followed the protocols of the Institution of Animal Care and Use Committee of the National Institute of Animal Science (NIAS 20212219).

### 2. Experimental Animals

This study used three hundred eighty-two KNC-R (190 males, 192 females) raised at the National Institute of Animal Science's farm in Pyeongchang, South Korea. We sampled chickens from two different batches (batch 1; males: 98, females: 92; batch 2; males: 92, females: 100). The chickens from batch 1 were produced in 2021 whereas chickens from batch 2 were produced in 2022 but all chickens were reared under the same conditions. Housing, hatching, management, feeding, slaughtering (the neck cut method targeting a jugular vein and a carotid artery, followed by removal of blood), and conditions for carcass storage are explained in our previous work (Kim et al., 2023).

### 3. Fatty Acid Analysis

We analyzed the composition of the fatty acids from the breast meat of three hundred eighty-two KNC-R slaughtered at 10 weeks old. The fatty acids were extracted by the fatty acid methyl ester method following all steps as explained by Lee et al. (2021). 24 Fatty acid traits were measured and expressed in percentage as reported in our previous work (Munyaneza et al., 2024).

### 4. Statistical Analysis

We used a 2-way ANOVA to assess the effects of batch and sex on the contents of the fatty acid in KNC-R chickens. All the analyses were performed by using the R program (R Core Team R, 2022). The significance level was $P<0.05$.

## RESULTS AND DISCUSSION

### 1. Descriptive Statistics of the Fatty Acids in KNC-R Aged 10 Weeks

Descriptive statistics for the different fatty acid profiles in three hundred eighty-two KNC-R aged of 10 weeks are shown in Table 1. The following fatty acids: oleic acid (28.252%); palmitic acid (20.895%), linoleic acid (15.975%), and arachidonic acid (10.541%) were the main fatty acids in the breast meat of KNC-Rs (Table 1). These results are in agreement with previous findings (Jayasena et al., 2013; Cho et al., 2023). Comparing the composition of fatty acids in different breeds, Korean native chickens have a higher content of arachidonic

Table 1. Basic statistics of fatty acid composition (%) of three hundred eighty-two KNC-R aged 10 weeks

| Category | Trait | Mean | S.D. | CV (%) | Max | Min |
|---|---|---|---|---|---|---|
| SFA | C14:0 | 0.326 | 0.126 | 0.016 | 2.13 | 0.16 |
| | C16:0 | 20.895 | 1.368 | 1.871 | 25.16 | 14.88 |
| | C18:0 | 9.736 | 1.112 | 1.236 | 12.66 | 6.25 |
| | SFA | 30.956 | 0.971 | 0.942 | 33.45 | 27.74 |
| MUFA | C16:1 | 2.281 | 0.924 | 0.853 | 5.47 | 0.61 |
| | C18:1 | 28.252 | 3.896 | 15.178 | 40.63 | 20.1 |
| | C24:1 | 1.059 | 0.312 | 0.097 | 2.12 | 0.34 |
| | MUFA | 32.836 | 4.186 | 17.523 | 46.94 | 24.11 |
| PUFA | C18:2[2] | 15.975 | 1.789 | 3.2 | 21.43 | 3.87 |
| | C18:3[1] | 0.285 | 0.68 | 0.462 | 13.5 | 0.14 |
| | C20:2[2] | 0.393 | 0.107 | 0.011 | 0.77 | 0.13 |
| | C20:3[1] | 1.181 | 0.267 | 0.071 | 1.8 | 0.37 |
| | C20:4[2] | 10.541 | 2.685 | 7.208 | 19.07 | 1.48 |
| | C20:5[1] | 0.206 | 0.569 | 0.324 | 11.25 | 0.06 |
| | C22:6[1] | 1.059 | 0.312 | 0.097 | 2.12 | 0.34 |
| | PUFA | 29.637 | 3.08 | 9.487 | 36.84 | 20.05 |
| Omega-3 | n-3[1] | 2.729 | 1.32 | 1.742 | 26.51 | 1.17 |
| Omega-6 | n-6[2] | 26.908 | 2.95 | 8.702 | 33.72 | 5.69 |
| MUFA+PUFA | UFA | 62.472 | 1.566 | 2.452 | 69.04 | 59.13 |
| Ratio | UFA/SFA | 2.021 | 0.099 | 0.01 | 2.41 | 1.81 |
| | P/S | 0.959 | 0.109 | 0.012 | 1.25 | 0.62 |
| | n-6/n-3 | 10.375 | 1.845 | 3.403 | 18.84 | 0.21 |
| AI | AI | 0.355 | 0.026 | 0.001 | 0.51 | 0.25 |
| TI | TI | 0.814 | 0.044 | 0.002 | 0.93 | 0.3 |

[1] Omega (ω)-3 fatty acid.
[2] Omega (ω)-6 fatty acid.
AI: atherogenicity index, TI: thrombogenicity index, S.D.: standard deviation, CV: coefficient of variation.

acid (C20:4) and fewer oleic acid (C18:1) compared to broilers (Jayasena et al., 2013). The composition of the fatty acids has an effect on meat quality and consumer's health.

The composition of diet is one the environmental factors which affect the composition of the fatty acid. The diet fed to chickens has a great effect on the content of fatty acid in chicken meat. As non-ruminant, chicken does not change the lipid and fatty acids in the diet (Del Puerto et al., 2017). For example, feeding chickens with diet which is rich in omega-fatty acids will produce meat with a higher content of omega-3 fatty acids such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). In this study, we also calculated indices known to assess the nutritional quality of the dietary fats, including P/S, AI, and TI indices. The P/S is the index used to assess the dietary impact on cardiovascular health, and the higher ratio is more desirable (Chen and Liu, 2020). The index for P/S in chicken meat ranges between 0.308−2.042 (Chen and Liu, 2020). The P/S of the current study was 0.959, which is in the range of previous results (Chen and Liu, 2020).

The AI is the ratio of SFAs which promote atherogenicity: (C12:0, C14:0, and C16:0) and UFAs (Jayasena et al., 2013; Garcia et al., 2021), whereas the TI is the ratio of SFA which promote thrombogenicity: (C14:0, C16:0, and C18:0) and MUFAs and PUFAs (Pretorius and Schonfeldt, 2021). The AI and TI in chicken meat ranges between 0.165−0.634 and 0.288−1.694, respectively (Chen and Liu, 2020). The results of the present study for AI and TI were 0.355 and 0.814, respectively.

These findings are in the same range as previous results (Chen and Liu, 2020). The indices of AI and TI are very good indicators of the quality of the fat in the meat. The lower index is desirable because it shows that the meat is healthier as it contains fewer SFAs and more MUFA and PUFA (Pretorius and Schonfeldt, 2021; Vázquez- Mosquera et al., 2023).

## 2. Effect of Batch and Sex on the Content of Fatty Acid in KNC-R Aged 10 Weeks

Genetic factors such as breed or line and environmental factors such as diet and meat portion influence the content of fatty acids in muscle (Jayasena et al., 2014; Duan et al., 2023). Meat portion (breast or leg) has a great influence on the content of fatty acid. The contents of oleic and linoleic acids were higher in leg compared to breast meat of Korean native chickens whereas the contents of arachidonic acid and docosahexaenoic acid were higher in breast than leg of Korean native chickens (Jayasena et al., 2014). The content of fatty acid in breast meat varies between male and female chickens. The results of our study showed that male KNC-R have a higher content of eicosadienoic acid (C20:2) and PUFA but lower content in oleic acid (C18:1), MUFA and UFAs compared to female KNC-R (Table 2). Our study detected the significant effect of batch on the content of fatty acid in the breast meat of KNC-R except for linolenic acid (C18:3) and eicosapentaenoic acid (EPA:C20:5) (Table 2). The C18:3 and C20:5 are n-3

**Table 2.** Effects of batch and sex on the content of fatty acid in KNC-R aged 10 weeks

| Trait (in %) | Batch | | *P*-value | Sex | | *P*-value |
|---|---|---|---|---|---|---|
| | Batch 1 | Batch 2 | | Male | Female | |
| C14:0 | $0.282 \pm 0.062^{b}$ | $0.366 \pm 0.155^{a}$ | $P<0.001$ | $0.320 \pm 0.082$ | $0.329 \pm 0.157$ | 0.629 |
| C16:0 | $20.073 \pm 1.131^{b}$ | $21.706 \pm 1.064^{a}$ | $P<0.001$ | $20.858 \pm 1.243$ | $20.930 \pm 1.483$ | 0.916 |
| C18:0 | $10.281 \pm 0.958^{a}$ | $9.195 \pm 0.984^{b}$ | $P<0.001$ | $9.725 \pm 1.098$ | $9.746 \pm 1.128$ | 0.537 |
| SFA | $30.638 \pm 0.962^{b}$ | $31.270 \pm 0.873^{a}$ | $P<0.001$ | $30.904 \pm 0.883$ | $31.007 \pm 1.049$ | 0.396 |
| C16:1 | $1.999 \pm 0.738^{b}$ | $2.558 \pm 1.002^{a}$ | $P<0.001$ | $2.319 \pm 0.908$ | $2.241 \pm 0.939$ | 0.273 |
| C18:1 | $27.736 \pm 3.540^{b}$ | $28.760 \pm 4.164^{a}$ | 0.009 | $27.664 \pm 3.742^{b}$ | $28.832 \pm 3.965^{a}$ | 0.004 |
| C24:1 | $2.495 \pm 0.515^{a}$ | $2.113 \pm 0.558^{b}$ | $P<0.001$ | $2.359 \pm 0.547$ | $2.248 \pm 0.588$ | 0.078 |
| MUFA | $32.230 \pm 3.721^{b}$ | $33.433 \pm 4.530^{a}$ | 0.004 | $32.343 \pm 4.0544^{b}$ | $33.321 \pm 4.267^{a}$ | 0.027 |
| C18:2 | $15.507 \pm 2.103^{b}$ | $16.436 \pm 1.253^{a}$ | $P<0.001$ | $16.034 \pm 1.864$ | $15.914 \pm 1.713$ | 0.386 |
| C18:3 | $0.331 \pm 0.961$ | $0.237 \pm 0.057$ | 0.179 | $0.309 \pm 0.963$ | $0.259 \pm 0.052$ | 0.504 |
| C20:2 | $0.438 \pm 0.106^{a}$ | $0.347 \pm 0.084^{b}$ | $P<0.001$ | $0.411 \pm 0.09^{a}$ | $0.374 \pm 0.111^{b}$ | 0 |
| C20:3 | $1.208 \pm 0.234^{a}$ | $1.153 \pm 0.293^{b}$ | 0.045 | $1.198 \pm 0.258$ | $1.162 \pm 0.273$ | 0.212 |
| C20:4 | $11.241 \pm 2.461^{a}$ | $9.847 \pm 2.722^{b}$ | $P<0.001$ | $10.733 \pm 2.666$ | $10.349 \pm 2.696$ | 0.210 |
| C20:5 | $0.228 \pm 0.805$ | $0.182 \pm 0.0549$ | 0.431 | $0.242 \pm 0.804$ | $0.168 \pm 0.048$ | 0.212 |
| C22:6 | $1.091 \pm 0.285^{a}$ | $1.025 \pm 0.333^{b}$ | 0.036 | $1.029 \pm 0.300$ | $1.087 \pm 0.321$ | 0.059 |
| PUFA | $30.046 \pm 2.761^{a}$ | $29.229 \pm 3.323^{b}$ | 0.009 | $29.959 \pm 2.81^{a}$ | $29.316 \pm 3.297^{b}$ | 0.049 |
| n-3 | $2.859 \pm 1.780$ | $2.598 \pm 0.553$ | 0.053 | $2.780 \pm 1.797$ | $2.676 \pm 0.520$ | 0.486 |
| n-6 | $27.187 \pm 3.027$ | $26.630 \pm 2.851$ | 0.064 | $27.179 \pm 2.933$ | $26.639 \pm 2.949$ | 0.084 |
| UFA | $62.277 \pm 1.628^{b}$ | $62.662 \pm 1.480^{a}$ | 0.015 | $62.302 \pm 1.621^{b}$ | $62.638 \pm 1.494^{a}$ | 0.043 |
| UFA/SFA | $2.035 \pm 0.103^{a}$ | $2.006 \pm 0.091^{b}$ | 0.003 | $2.018 \pm 0.096$ | $2.023 \pm 0.100$ | 0.567 |
| P/S | $0.982 \pm 0.103^{a}$ | $0.935 \pm 0.110^{b}$ | $P<0.001$ | $0.970 \pm 0.095$ | $0.947 \pm 0.120$ | 0.059 |
| n-6/n-3 | $10.180 \pm 1.973^{b}$ | $10.567 \pm 1.690^{a}$ | 0.039 | $10.518 \pm 1.945$ | $10.233 \pm 1.733$ | 0.112 |
| AI | $0.340 \pm 0.020^{b}$ | $0.369 \pm 0.021^{a}$ | $P<0.001$ | $0.355 \pm 0.022$ | $0.355 \pm 0.028$ | 0.631 |
| TI | $0.802 \pm 0.048^{b}$ | $0.825 \pm 0.033^{a}$ | $P<0.001$ | $0.813 \pm 0.049$ | $0.814 \pm 0.037$ | 0.987 |

[a, b] Means within a raw with different superscripts differ significantly ($P<0.05$).

n-3: omega-3, n-6: omega-6, UFA: unsaturated fatty acid, UFA/SFA: ratio between unsaturated fatty acid and saturated fatty acid, AI: atherogenicity index, TI: thrombogenicity index.

PUFAs whose contents are mainly influenced by diet. The composition of the fatty acid in the meat depends on many factors and has a huge role in the quality of the meat and affects health of consumers. Further studies are required to validate the results of the current study.

## SUMMARY

The content of fatty acids is influenced by genetic and environmental factors. This study found 4 main fatty acids in the breast of the KNC-R, MUFA: oleic acid (C18:1) followed by SFA: palmitic (C16:0), and two omega-6 PUFAs: linoleic (C18:2), and arachidonic (C20:4). Moreover, the indices used to assess the nutritional quality of fat in the diet: P/S, AI, and TI were 0.959, 0.355, and 0.814, respectively. This study confirmed the effects of the batch and sex on the content of the fatty acid in the breast meat of KNC-R. Assessing the content of fatty acid in chicken meat is very important because it helps consumers to make choices aligned with their preferences related to their health and to take a balanced diet in terms of essential fatty acids.

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