Fatty acid profiles of egg yolk and albumen from Cemani and White Leghorn chickens

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Abstract. The composition of the yolk and albumen content in the egg was 60 and 30%, respectively. The purpose of this paper is to examine the fatty acid profile (FA) of egg yolk and albumen in cemani and white leghorn chickens. Cemani and white leghorn chickens were given a commercial feed of 110 g/head/day, and drinking water was given ad libitum. Two fresh eggs from each hen were used in this study to examine egg yolk and albumen fatty acids by gas chromatography. The data obtained were analyzed statistically with an independent sample T-test. The results showed that the FA profiles of egg yolk and albumen were not significantly different (P>0.05) for the parameters of saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), and polyunsaturated fatty acids (PUFA) from chicken. Cemani and white leghorn chickens, monounsaturated fatty acids (MUFA) are found in more amounts than SFA and PUFA in egg yolks and albumen. It can be concluded that the FA profiles of cemani and white leghorn chickens are almost the same.

1. Introduction
Eggs are the cheapest and best source of protein and are consumed by almost everyone. Egg structure consists of albumen (±60%), yolk (±30%), and shell (±10%). Albumen is a clear fluid contained in the egg and is formed from the secretory layer of the anterior part of the oviduct during the egg’s passage. About 10% consists of water-soluble protein. Its main function is to protect the yolk, and provide additional nutrition for embryo growth, it is rich in protein, and contains almost no fat, unlike egg yolks which have a high-fat value. The yolk is the part of the yolk ball that is surrounded by albumen, and functions to feed the developing embryo.

The plants, animal tissue, and animal products contain a substance called fat. One example of fat that comes from animal sources, namely from eggs. The fat content in eggs varies depending on the genetic type. Fatty acids are the main building blocks of fat. Based on the level of saturation, fatty acids can be divided into three major subsections, namely saturated fatty acids (SFA) that do not have double bonds, for example, palmitic acid; monounsaturated fatty acids (MUFA) have one double bond, for example, oleic acid; and polyunsaturated fatty acids (PUFA) which have > 2 double bond, for example, omega-3 and omega-6 fatty acids [1].

Cemani chicken is one of the rarest chickens in the world [2], and has broad market prospects, not only limited to local markets but also global markets [3]. In Indonesia, sometimes it is also used in medicine and ritual ceremonies [4]. In addition, cemani chicken also has a high resistance to disease, especially viral infections, and intestinal pathogens [4,5].
White leghorn chicken is chicken that serves as a genetic basis for producing an egg. In addition, white leghorn chicken has the advantage of fast growth, and are not aggressive [6]. Cemani chicken is a local chicken that still needs to be observed to know the potential of this chicken. In Indonesia, the identification of fatty acids found cemani and white leghorn chickens has not been reported. So, the purpose of writing a paper is to look at the profiles of fatty acids (FA) that exist in egg yolk and albumen in cemani, and white leghorn chickens.

2. Materials and methods
The maintenance of cemani and white leghorn chickens of the colony (1 male: 5 female). Cemani and white leghorn chickens are given commercial feed with nutritional content (table 1) of 110 g/head/day, and drinking water is given ad libitum. Egg collection is carried out every day between 09.30–12.00 WIB. Eggs are marked according to the species of chickens, cages, and date of laying. Two fresh eggs from each chicken were used in this study to examine the fatty acids present in egg yolk and albumen by gas chromatography according to AOAC [7]. The variables observed in the study were the percentage of fatty acid (SFA, MUFA, and PUFA) found in egg yolks and albumen. Data obtained at averages are then compared with the independent-sample T-test using the help of the SPSS Statistics version 22.0.

Table 1. The nutritional content of commercial feed given to Cemani and White Leghorn chickens.

| Contents       | Percentage (%) |
|----------------|----------------|
| Water content  | 12             |
| Crude protein  | 16.5–18        |
| fat            | 3              |
| fiber          | 6              |
| Ash            | 13.5           |
| Calcium        | 3.25–4.25      |
| Phosphor       | 0.45           |

3. Results and discussion

3.1. Egg yolk
The fatty acid composition of eggs varies widely with the possibility of differences in chicken feed. However, collectively, it is clear that SFA is less variable than MUFA and PUFA [8]. The SFA group in the cemani chicken egg yolk sample was more than that of white leghorn chicken (table 2). However, the profile of the origin of SFA fat in egg yolk was not influenced by chicken species (P>0.05). The results of this study differ from those reported by Mustonen et al (2009), the variation of fatty acids is influenced by species [9]. The absence of differences in egg yolk SFA was most likely due to the same feed given to cemani and white leghorn chickens, namely the commercial feed for laying (P>0.05). However, if the feed given is different, it will affect the acid variation [10].

As for the MUFA group, cemani chicken was more than white leghorn chicken. However, after the independent sample T-test, there was no difference (P>0.05). The possibility of this is because there are only 2 MUFA groups in the study, namely Cis-10-Heptadecanoic acid (C17:1), and Oleic acid (C18:1n9c). The percentage of oleic acid (C18:1n9c) in the study is lower than the previous one reported [11] and [12], namely 44.90 and 47.92%, respectively. Thus the percentage of total MUFA in this study was also lower than that reported [12], namely 54.08%.

Unlike the two previous fatty acids, PUFA fatty acid in cemani chicken is less than those in white leghorn chicken. However, it did not significant (P>0.05). The low PUFA in cemani chicken enables...
the conversion of PUFA in cemani chicken livers to be very efficient. This is similar to previously reported for commercial layer egg [8,14].

The percentages of linoleic (C18:2n6c), γ-linolenic (C18:3n6), and linolenic acid (C18:3n3) in the study were lower than those reported by Altuntas (2014) which could reach 16.46, 0.14, and 0.54%, and Cherian Quezada (2016) the percentage of linoleic (C18:2n6c), and γ-linolenic acid (C18:3n6) could reach 51.71, and 5.19%, respectively [11,12]. Meanwhile, for cis-11,14-eicosadienoic acid (C20:2) the white leghorn chicken was higher than that reported by Altuntas (2014) which was only 0.15% [11]. Thus, differences in the studies of fatty acid profiles with those previously reported by researchers are influenced by feed, chicken age, and geographical location [15].

Table 2. Fatty acid profiles found in egg yolk samples.

| Parameter                                           | Chickens            | Statistic test |
|-----------------------------------------------------|---------------------|----------------|
|                                                     | Cemani | White Leghorn |               |
| Myristic acid (C14:0)                               | 0.28   | 0.29          |               |
| Palmitic acid (C16:0)                               | 23.53  | 22.14         |               |
| Heptadecanoic acid (C17:0)                          | 0.07   | 0.11          |               |
| Arachidic acid (C20:0)                              | 0.04   | 0.03          |               |
| SFA                                                 | 23.92±11.70        | 22.57±11.00    | ns             |
| Cis-10-Heptadecanoic acid (C17:1)                   | 0.11   | 0.02          |               |
| Oleic acid (C18:1n9c)                               | 39.55  | 36.14         |               |
| MUFA                                                | 39.66±27.89        | 36.16±25.54    | ns             |
| Linoleic acid (C18:2n6c)                            | 14.54  | 14.97         |               |
| Cis-11,14-Eicosadienoic acid (C20:2)                | 0.07   | 0.16          |               |
| γ-Linolenic acid (C18:3n6)                          | 0.10   | 0.07          |               |
| Linolenic acid (C18:3n3)                            | 0.16   | 0.31          |               |
| Cis-8, 11, 14-Eicosatrienoic acid (C20:3n6)         | 0.15   | 0.13          |               |
| PUFA                                                | 15.02±3.77         | 28.51±6.62     | ns             |
| Total fatty acid                                    | 78.43  | 80.97         |               |

Laboratory analysis results of testing, calibration and certification services, Bogor Agricultural University, ns=non significant.

The total fatty acid of the white leghorn chicken egg yolk is higher than that in the cemani chicken, which is 80.97 vs 78.43%. This result of the study is because, the fat content in purebred chicken eggs (example white leghorn) is higher compared to free-range chicken (example cemani), which is 11.3 vs 10.3% [16] so that the total fatty acid of white leghorn chicken will be more.

3.2. Albumen

Albumen are a source of complete protein, and contain all the amino acids the body needs for protein synthesis. Although albumen is a source of low fat and high protein nutrition, a small percentage of people cannot eat it because of egg allergy associated with some proteins.

Almost the same as the fatty acid profiles found in egg yolk, the SFA albumen fatty acid in cemani chicken were more than those in white leghorn chicken (table 3). After being analyzed by an independent sample T-test, there was not significant (P>0.05). In cemani chicken, the percentage of myristic acid (C14:0) is less than compared to white leghorn chicken. However, for other SFA, cemani chicken is more than white leghorn chicken, so the total SFA in cemani chicken is more than compared to white leghorn chicken.

The profile of MUFA fat chicken, cemani chicken is less than compared to white leghorn chicken. After being tested by an independent sample T-test, there was not significant (P>0.05). However, if we look at the profiles of palmitoleic acid (C16:1), and cis-10-Heptadecanoic acid (C17:1) fatty acids in cemani chicken are more than white leghorn chicken, except for oleic acid (C18:1n9c) is less. While for
cis-11-Eicosenoic acid (C20:1) the percentage of fatty acids in cemani and white leghorn chickens are the same, which is 0.03%.

Table 3. Fatty acid profile found in albumen samples

| Parameter                                      | Cemani         | White Leghorn | Statistik test |
|-----------------------------------------------|----------------|---------------|----------------|
| Myristic acid (C14:0)                         | 0.26           | 0.29          |                |
| Pentadecanoic acid (C15:0)                    | 0.04           | 0.08          |                |
| Palmitic acid (C16:0)                         | 20.37          | 19.28         |                |
| Heptadecanoic acid (C17:0)                    | 0.07           | 0.06          |                |
| Arachidicacid (C20:0)                        | 0.02           | 0.03          |                |
| Lignoceric acid (C24:0)                       | 0.01           | 0.02          |                |
| SFA                                           | 20.77±8.28     | 19.76±7.83    | ns             |
| Palmitoleic acid (C16:1)                      | 3.05           | 2.92          |                |
| Cis-10-Heptadecanoic acid (C17:1)             | 0.11           | 0.09          |                |
| Cis-11-Eicosenoic acid (C20:1)                | 0.03           | 0.03          |                |
| Oleic acid (C18:1n9c)                         | 31.80          | 32.38         |                |
| MUFA                                          | 34.99±15.53    | 35.42±15.74   | ns             |
| Linoleic acid (C18:2n6c)                      | 8.51           | 9.86          |                |
| Cis-11,14-Eicosadienoic acid (C20:2)          | 0.14           | 0.15          |                |
| y-Linolenic acid (C18:3n6)                    | 0.08           | 0.09          |                |
| Linolenic acid (C18:3n3)                      | 0.17           | 0.18          |                |
| Cis-8, 11, 14-Eicosatetraenoic acid (C20:3n6)| 0.13           | 0.16          |                |
| Arachidonic acid (C20:4n6)                    | 1.65           | 1.59          |                |
| Cis-5, 8, 11, 14, 17-Eicosapentaenoic acid    | 0.02           | 0.02          |                |
| (C20:5n3)                                     |                |               |                |
| PUFA                                          | 10.70±3.13     | 12.05±3.63    | ns             |
| Total fatty acid                              | 66.55          | 67.23         |                |

Laboratory analysis results of testing, calibration and certification services, Bogor Agricultural University, ns=non significant.

In white leghorn chicken, PUFA profiles are more than cemani chicken. However, after being tested with an independent sample T-test it did not significant (P>0.05). The percentage of PUFA profile of cemani chicken is more than that of white leghorn chicken except for arachidonic acid (C20:4n6), while the other fatty acid profiles in white leghorn chicken are more, namely for linoleic acid (C18:2n6c), cis-11,14-eicosadienoic acid (C20:2), y-linolenic acid (C18:3n6), and linolenic acid. As for cis-5, 8, 11, 14, 17-eicosapentaenoic acid (C20:5n3), the percentage of fatty acids in cemani and white Leghorn chickens are the same, which is 0.02%. So that the total PUFA of white leghorn chicken is more than cemani chicken.

The total fatty acid albumen of white leghorn chicken is more than that in cemani chicken, which is 67.23 vs 66.55%. This is because, the fat content in purebred chicken eggs (example white leghorn) is more compared to free-range chicken (example cemani), which is 11.3 vs 10.3% [16] so that the total fatty acid of white leghorn chicken will be more.

So, the percentage of SFA and MUFA fatty acids in the albumen is less than in the egg yolk. The less percentage of SFA, and MUFA fatty acids in the albumen is caused by the less albumen fat content compared to egg yolk. The percentage of PUFA fatty acids in cemani chickens were more than egg yolks, but the percentage of PUFA fatty acids in albumin were less than egg yolks in white leghorn chicken [16–18].

In general, the results showed that the FA profiles (egg yolk and albumen) of cemani and white leghorn chickens were not different. This suggests that the breed does not affect the FA profile. Similar
results were reported Lordelo et al (2017) in free-range and commercial layer hens in which egg yolk and albumen content did not differ between races [14]. It is unlikely that production systems and breeds will influence broad characteristics [14].

4. Conclusion
The SFA, MUFA, and PUFA fatty acid profiles in egg yolks and albumen found in cemani and white leghorn chickens were almost the same from the samples examined. So that in this study, SFA, MUFA, and PUFA fatty acids are not affected by livestock species.

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