Amendment to Quality Parameters for Rice Bran Oil in the Codex Standard for Named Vegetable Oils

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Abstract: The objective of this study is to review the compliance of fatty acid compositions of Thai and India rice bran oil and level of desmethylsterols of Thai crude rice bran oil with the Codex Standard for Named Vegetable Oil (Codex Stan 210-1999). Fatty acid compositions of 90 samples of Thai and India refined rice bran oil were analyzed by capillary gas liquid chromatography. The results indicated that the contents of the C14:0, C18:2, C22:0 and C24:0 possible fall outside the range of Codex Stan 210-1999. In addition, sterol profile content of 40 samples of crude rice bran oil from Thai refinery plants were studied. The test results of major compositions of desmethylsterols are in good agreement with CODEX STAN 210-1999 except for Brassicasterol and other desmethylsterols. Accordingly, these data were proposed to corporate into the codex standard. Consequently, Codex agreed to amend the fatty acid composition of C14:0, C18:2, C22:0 and C24:0 from ND to 1.0, 21 to 42, ND to 1.0 and ND to 0.9 % and broaden level of Brassicasterol and other desmethylsterols to “ND-0.3” and to “7.5-12.8” accordingly.

Key words: rice bran oil, fatty acid composition, desmethylsterols

1 Introduction  
Codex Standard for Named Vegetable Oils (CODEX STAN 210-1999 or CXS 210-1999) defines edible vegetable oils are foodstuffs which are composed primarily of glycerides of fatty acids being obtained only from vegetable sources. CXS 210-1999 contains essential composition and quality factors of 30 vegetable oils and their supplementary information together with requirements on food additives, contaminants, hygiene, labelling and method of analysis. Section 3 composition and quality factors refers to GLC ranges of fatty acid composition (specified in Table 1) and describes that samples falling within the appropriate ranges specified in Table 1 are in compliance with this Standard. Therefore, fatty acid compositions are key parameters in vegetable oils characterization to ensure oil authenticity. Table 2 of CXS 210-1999 shows the chemical and physical characteristics related to crude vegetable oils. Table 4 expresses the levels of desmethylsterols in crude vegetable oils. Since some of these sterols are unique to each vegetable oil, their sterol profile can be applied as detection criteria as fatty acids in oil authentication testing. For example, brassicasterol is used in detection of rape-seed oil in sunflower seed or groundnut oils.

Rice bran oil is edible oil extracted from outer layer of the white rice. It usually used as an excipient in food, industry. Global rice bran oil market size was estimated at over 1.7 million tons in 2017. The abundant raw material availability in the form of rice particularly in Asian countries is the reason for higher production volumes of rice bran oil in these countries. The major producer was India (1,000,000 tons), China (440,000 tons) and Thailand (134,000 tons) (CCFO, 2019).

The 22nd CCFO considered Thailand’s proposal on the amendment of the level of desmethylsterols levels and composition of fatty acids in rice bran oil and highlight the need for more data on sterol contents. Member countries were invited to provide more samples. Consequently, Thailand by the National Bureau of Agricultural Commodity and Food Standards (ACFS) undertake additional study desmethylsterols levels to be presented for reviewing in the CCFO.

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2 Materials and Methods

2.1 Fatty acids composition of refined rice bran oils

45 samples of commercial refined rice bran oil, analyzed in 2011-2012, submitted by the National Bureau of Agricultural Commodity and Food Standards (ACFS), Ministry of Agriculture and Cooperatives, Thailand. 30 samples were analyzed in 2010 with AOAC 969.33 and AOAC 963.22 and 2011 with AOCS Ce 2-66.

2.2 Level of desmethylsterols

3 Results and Discussion

3.1 Fatty acids composition

It was observed that the minimum and maximum values of the fatty acid profile of refined Thai rice bran oil of 2011-2012 fell within the specific range for Rice Bran Oil in Table 1 of the Codex Standard for Named Vegetable Oils.
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Table 3  Fatty acids composition of Thai and India refined rice bran oil from authentic samples.

| Fatty acid | CXS 210-1999 | Refined (Thai and India, n=90) |
|------------|--------------|-------------------------------|
|            | Min  | Max  | Mean | SD   | x ± 3σ | Range |
| C14:0      | 0.1  | 0.7  | 0.4  | 0.2  | 0.4 ± 0.6 | ND-1.0 |
| C18:2      | 29-40| 37.7 | 31.5 | 3.5  | 31.5 ± 10.5 | 21-42 |
| C22:0      | ND-0.5| 1.0  | 0.4  | 0.2  | 0.4 ± 0.6 | ND-1.0 |
| C24:0      | ND-0.6| 0.5  | 0.3  | 0.2  | 0.3 ± 0.6 | ND-0.9 |

However, considering to the \( \bar{x} \pm 3\sigma \), the present data of Thai RBO samples indicated a possible out of Codex’s range for C14:0, C18:2, C22:0 and C24:0. In this case, it may reflect from natural variations such as variety of rice, season, geographical location, climate variability or growing conditions. The analytical results of each fatty acid composition of refined rice bran oil are presented in Table 1.

3.1.2 Fatty acids composition of India refined rice bran oil from authentic samples

Table 2 shows the proposal of India for the proposed range of six fatty acid composition significantly different from the CXS 210-1999.

Thailand had called for additional data. New calculation was performed based on 90 samples of Thailand and India. Deviation range have been found for myristic acid(C14:0), linoleic acid(C18:2)and long chain fatty acid of behenic acid(C22:0)and lignoceric acid(C24:0). Based on this result, the presence of behenic acid(C22:0) were found higher than CXS 210-1999 while the calculated lignoceric acid(C24:0) are possible out of range.

It is also observed that these long chains fatty acid are found only in the samples of refined rice bran oil from Thailand. Similar results were found in Jean-François Morin et al.’s study in 2017. In response to these variations, the proposal for the amendment of the 4 fatty acid compositions of rice bran oil in Table 3 of CODEX STAN 210-1999 was submitted for consideration at the 23rd CCFO.

3.2 Levels of desmethylsterols in crude Rice Bran Oil from authentic samples

The analysis of each desmethylsterols as identified in CODEX STAN 210-1999 and other desmethylsterols in crude rice bran oil are presented in Table 4.

According to the results in Table 4, it can be observed that the level of 7 major compositions of desmethylsterols (Cholesterol, Campesterol, Stigmasterol, Beta-sitosterol, Delta-5-avenasterol, Delta-7-stigmastenol and Delta-7-avenasterol) found in 40 crude rice bran oil samples are in good agreement with CODEX STAN 210-1999 except for Brassicasterol and Other desmethylsterols. For Thai samples, Brassicasterol were detected in trace amounts whereas this sterol was not present in the U.S. samples. The minimum, maximum, means(\( \bar{x} \)) and standard deviation (\( \sigma \)) of brassicasterol found in 40 samples were 0.1, 0.2, 0.1 and 0.07% respectively.

In addition, small proportions of other desmethylsterols; 24-methylene-cholesterol, Campestanol, Chlerosterol, Sitostanol, Delta-5, 23-stigmastadienol, Delta-5, 24-stigmastadienol and Delta-7-campesterol were observed in Thai samples whilst Campestanol, Sitostanol and 6 unknowns were found in the U.S. samples. These desmethylsterols together were reported as sum of other desmethylsterols. From the analysis data, it is observed that the sum of other desmethylsterols from Thailand and the U.S. fall within the same range. The minimum, maximum, means (\( \bar{x} \)), standard deviation(\( \sigma \))and sum of other desmethylsterols of 40 crude rice bran oil samples were 8.79, 12.62, 9.95 and 0.69 % respectively. There are significant differences of means(\( \bar{x} \))between Thailand and the U.S. data. The level of Brassicasterol and other desmethylsterols of the two sets of data are combined and reported in the last column of Table 4.

4 Conclusions

The present study shows significant understanding the current and trend of fatty acid composition of rice bran oil and level of desmethyl sterol which may vary due to natural variation. The results of this study are useful for the government agencies initiatives in making a proposal for amending the codex standard in which national data is an important tool for codex to assess and make decision for further amendment. As a result, the 36th CAC adopted the amendment to parameters for rice bran oil in the Standard for Named Vegetable Oils and the new text is now published in the CXS 210-1999 amended in 2019 as follows:

Fatty acid composition

Amend C14:0 from "0.1-0.7" to "ND-1.0" Amend C18:2 from "29-40" to "21-42" Amend C22:0 from "ND-0.5" to "ND-1.0" Amend C24:0 from "ND-0.6" to "ND-0.9"
| Compound                  | Crude (TH, n=30) | Crude (US, n=10) | Crude (TH & US, n=40) |
|--------------------------|------------------|------------------|-----------------------|
|                          | Min     | Max     | Mean    | σ       | Range    | Min     | Max     | Mean    | σ       | Range    |
| Cholesterol              | ND-0.5  | 0.10    | 0.20    | 0.17    | 0.005    | ND      | ND      | ND      | ND      | ND       |
| Brassicasterol            | ND      | 0.10    | 0.20    | 0.17    | 0.05     | ND      | ND      | ND      | ND      | ND       |
| Campesterol              | 11.0-35.0 | 17.10   | 24.30   | 22.80   | 2.60     | 20.45   | 24.40   | 23.35   | 1.80    | 19.36    |
| Stigmasterol             | 6.0-40.0 | 11.30   | 17.00   | 14.10   | 0.30     | 12.72   | 15.32   | 14.75   | 0.90    | 12.89    |
| Beta-sitosterol          | 25.0-67.0 | 43.40   | 48.60   | 46.50   | 1.65     | 48.26   | 51.84   | 50.14   | 1.19    | 46.08    |
| Delta-5-avenasterol      | ND-9.9  | 3.20    | 3.90    | 3.60    | 0.16     | 2.11    | 2.98    | 2.48    | 0.23    | 2.11     |
| Delta-7-stigmastenol     | ND-14.1 | 0.80    | 5.80    | 3.39    | 1.08     | 2.07    | 3.22    | 2.69    | 0.36    | 2.07     |
| Delta-7-avenasterol      | ND-4.4  | 0.70    | 1.80    | 1.40    | 0.38     | 0.81    | 2.91    | 2.58    | 0.52    | 2.11     |
| Other Desmethylsterols   | ND-11.1  | 0.50    | 1.50    | 1.00    | 0.20     | 0.70    | 1.30    | 1.04    | 0.14    | 0.70     |
| Campestanol             | 0.10    | 0.20    | 0.15    | 0.10    | 0.005    | 0.10    | 0.50    | 0.15    | 0.10    | 0.005    |
| Sitostanol              | 0.70    | 1.30    | 1.04    | 1.04    | 0.14     | 0.70    | 1.30    | 1.04    | 1.04    | 0.14     |
| Cholesterol              | ND-0.5  | 0.10    | 0.20    | 0.17    | 0.005    | ND      | ND      | ND      | ND      | ND       |
| Brassicasterol            | ND      | 0.10    | 0.20    | 0.17    | 0.05     | ND      | ND      | ND      | ND      | ND       |
| Campesterol              | 11.0-35.0 | 17.10   | 24.30   | 22.80   | 2.60     | 20.45   | 24.40   | 23.35   | 1.80    | 19.36    |
| Stigmasterol             | 6.0-40.0 | 11.30   | 17.00   | 14.10   | 0.30     | 12.72   | 15.32   | 14.75   | 0.90    | 12.89    |
| Beta-sitosterol          | 25.0-67.0 | 43.40   | 48.60   | 46.50   | 1.65     | 48.26   | 51.84   | 50.14   | 1.19    | 46.08    |
| Delta-5-avenasterol      | ND-9.9  | 3.20    | 3.90    | 3.60    | 0.16     | 2.11    | 2.98    | 2.48    | 0.23    | 2.11     |
| Delta-7-stigmastenol     | ND-14.1 | 0.80    | 5.80    | 3.39    | 1.08     | 2.07    | 3.22    | 2.69    | 0.36    | 2.07     |
| Delta-7-avenasterol      | ND-4.4  | 0.70    | 1.80    | 1.40    | 0.38     | 0.81    | 2.91    | 2.58    | 0.52    | 2.11     |
| Other Desmethylsterols   | ND-11.1  | 0.50    | 1.50    | 1.00    | 0.20     | 0.70    | 1.30    | 1.04    | 0.14    | 0.70     |
| Campestanol             | 0.10    | 0.20    | 0.15    | 0.10    | 0.005    | 0.10    | 0.50    | 0.15    | 0.10    | 0.005    |
| Sitostanol              | 0.70    | 1.30    | 1.04    | 1.04    | 0.14     | 0.70    | 1.30    | 1.04    | 1.04    | 0.14     |
| Cholesterol              | ND-0.5  | 0.10    | 0.20    | 0.17    | 0.005    | ND      | ND      | ND      | ND      | ND       |
| Brassicasterol            | ND      | 0.10    | 0.20    | 0.17    | 0.05     | ND      | ND      | ND      | ND      | ND       |
| Campesterol              | 11.0-35.0 | 17.10   | 24.30   | 22.80   | 2.60     | 20.45   | 24.40   | 23.35   | 1.80    | 19.36    |
| Stigmasterol             | 6.0-40.0 | 11.30   | 17.00   | 14.10   | 0.30     | 12.72   | 15.32   | 14.75   | 0.90    | 12.89    |
| Beta-sitosterol          | 25.0-67.0 | 43.40   | 48.60   | 46.50   | 1.65     | 48.26   | 51.84   | 50.14   | 1.19    | 46.08    |
| Delta-5-avenasterol      | ND-9.9  | 3.20    | 3.90    | 3.60    | 0.16     | 2.11    | 2.98    | 2.48    | 0.23    | 2.11     |
| Delta-7-stigmastenol     | ND-14.1 | 0.80    | 5.80    | 3.39    | 1.08     | 2.07    | 3.22    | 2.69    | 0.36    | 2.07     |
| Delta-7-avenasterol      | ND-4.4  | 0.70    | 1.80    | 1.40    | 0.38     | 0.81    | 2.91    | 2.58    | 0.52    | 2.11     |
| Other Desmethylsterols   | ND-11.1  | 0.50    | 1.50    | 1.00    | 0.20     | 0.70    | 1.30    | 1.04    | 0.14    | 0.70     |
| Campestanol             | 0.10    | 0.20    | 0.15    | 0.10    | 0.005    | 0.10    | 0.50    | 0.15    | 0.10    | 0.005    |
| Sitostanol              | 0.70    | 1.30    | 1.04    | 1.04    | 0.14     | 0.70    | 1.30    | 1.04    | 1.04    | 0.14     |
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Level of desmethylsterols

- Brassicasterol from "ND" to "ND-0.3"
- Other desmethylsterols from ND to "7.5-12.8"

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