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THE VITAMIN CONTENTS IN A VARIETY OF ITALIAN RICE AND IN ITS BYPRODUCTS.

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Rice is to be considered one of the most important cereals in human nutrition, since, as it is known, it is the basic daily diet of more than half the human race. Investigation on its composition represents, therefore, a remarkable contribution to the knowledge of its nutritional value.

To this end, a systematic research has been carried out by the authors upon a mean sample of Italian rice and its by-products, i.e., bran, germs and polishings. Their importance should not be overlooked due to their possible utilisation in the nutrition of various species of animals. Furthermore, this research attains a particular interest, as it affords a complete and comparative view for the vitamin factors of higher nutritonal value present in only one sample of rice and in its by-products, most of these data being not known in the literature.

EXPERIMENTAL

Materials and Methods

1. Material

The sample of rice and by-products utilized in the experiments were of the variety called "Originario" and consisted of: (1) reasonably well-milled rice, (2) brown-rice, (3) bran, (4) germs, (5) polishings.

2. Determination of Thiamine.

Thiamine was assayed by the thiochrome procedure (1) after extration and purification. To this end, the various sample were suspended in 0.1 N HCl and extracted in a boiling water-bath. Extracts were enzymatically digested with Taka-diastase at pH 4.8, and then the filtrate purified through a column containing activated Decalso. Thiamine, after oxidation to thiochrome, was determined fluorometrically in a Beckman Spectrophotometer (exciting light $\lambda = 365$ m$m\mu$, Corning filter No. 3389 for the fluorescent light).

3. Determination of Riboflavin

Riboflavin was assayed on samples after acid hydrolysis with 0.1 N HCl in an autoclave at 121° for 15 min. Estimation was carried out by the microbiological method utilizing L. casei ATCC 7469 as the test organism (3). The acidity produced after incubation at 37° for 72 hr was electrometrically titrated with 0.1 N NaOH.
4. **Determination of Pyridoxine.**
Pyridoxine was microbiologically assayed using *Neurospora sitophila* 299 ATCC 9276 (4). Samples were autoclaved for 14 hr after adding of 1 N NaOH and incubated with the test organism at 25°; the mycellium formed after 5-day incubation was weighed out.

5. **Determination of Vitamin B₁₂ Activity.**
The vitamin B₁₂ activity was assayed according to U. S. P. (8). After enzymatic digestion with papain and Taka-diastase at 37° for 40 hr (9), B₁₂ was microbiologically estimated using *L. leichmannii* ATCC 7830 as the test organism. The acidity produced after 72-hr incubation at 37° was electrometrically titrated with 0.1 N NaOH.

6. **Determination of Nicotinamide.**
Nicotinamide was determined according to the procedure described by Barton-Wright (5). After hydrolysis with 1 N HCl in an autoclave at 121° for 15 min, nicotinamide was microbiologically assayed on the hydrolysate using *L. arabinosus* 17/5 ATCC 8014 as the test organism. The acidity produced after 72-hr incubation at 30° was electrometrically titrated with 0.1 N NaOH.

7. **Determination of Pantothenic Acid.**
Pantothenic acid was microbiologically assayed using also *L. arabinosus* 17/5 ATCC 8014 as the test organism (6). Samples suspended in water were autoclaved at 121° for 15 min, enzymatically digested with Taka-diastase at 37° for 24 hr, then incubated with the test organism. The acidity produced after 72-hr incubation at 30° was electrometrically titrated with 0.1 N NaOH.

8. **Determination of Biotin.**
Biotin was also assayed with *L. arabinosus* 17/5 ATCC 8014. Hydrolysis of the sample was carried out in an autoclave at 121° for 30 min with 3 N H₂SO₄ (7).

9. **Determination of Folic Acid.**
Folic acid was determined according to the procedure described in the A. O. A. C. methods (10); after enzymatic digestion with dry chicken pancreas, folic acid was microbiologically assayed using *S. faecalis* R ATCC 8043 as the test organism. The acidity produced after 72-hr incubation at 37° was titrated with 0.1 N NaOH.

10. **Determination of Inositol.**
Inositol was iodometrically estimated according to Platt and Glock (12). Crude aqueous extracts of the sample were purified by eliminating both the 70 per cent acetone-insoluble and ether-soluble fractions. The purified extracts were then hydrolyzed with HCl and water-soluble inositol was oxidized with 0.01 N HIO₄. The possible error due to impurities was corrected by performing an additional analysis at the same low temperatures but using different times.

11. **Determination of Choline.**
Choline was assayed by the colorimetric Reineckate method described by György (13). The samples were extracted with methanol in a Soxhlet apparatus and the extracts hydrolysed by Ba(OH)₂ in a boiling water-bath. After filtration,
choline was precipitated by the Reinecke salt and the precipitate, after repeated washings with n-propanol, dissolved in acetone and then the absorbancy read at 520 m\(\mu\).

Carotenes were spectrophotometrically determined after extraction and purification (2, 11). Samples were repeatedly extracted with acetone, then the extracts purified by phasic partition between aqueous acetone and petroleum ether, followed by saponification. Carotenes were finally estimated on the unsaponifiable fraction in a spectrophotometer at 450 m\(\mu\).

Tocopherols were determined by the modified colorimetric method of Emmerie and Engels (14). Samples were extracted with acetone, then purified by phasic partition, followed by saponification. After treatment of the unsaponifiable fraction with the ferric chloride-\(\alpha, \alpha'\)-dipyridyl reagent, the color obtained was read in a photometer at 520 m\(\mu\).

**Results**
The data obtained are illustrated in Table I.

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Reasonably well-milled rice</th>
<th>Brown rice</th>
<th>Bran</th>
<th>Germs</th>
<th>Polishings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thiamine</td>
<td>0.035</td>
<td>0.24</td>
<td>1.15</td>
<td>4.53</td>
<td>0.36</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>0.033</td>
<td>0.057</td>
<td>0.30</td>
<td>0.36</td>
<td>0.28</td>
</tr>
<tr>
<td>Pyridoxine</td>
<td>0.120</td>
<td>0.160</td>
<td>1.03</td>
<td>1.52</td>
<td>0.96</td>
</tr>
<tr>
<td>B12 activity</td>
<td>0.000158</td>
<td>0.00005</td>
<td>0.0050</td>
<td>0.00105</td>
<td>0.0029</td>
</tr>
<tr>
<td>Nicotinamide</td>
<td>1.37</td>
<td>5.10</td>
<td>52.3</td>
<td>7.50</td>
<td>26.0</td>
</tr>
<tr>
<td>Pantothenic acid (as Ca salt)</td>
<td>0.34</td>
<td>0.66</td>
<td>4.50</td>
<td>1.32</td>
<td>2.60</td>
</tr>
<tr>
<td>Folic acid</td>
<td>—</td>
<td>0.060</td>
<td>0.135</td>
<td>0.165</td>
<td>0.098</td>
</tr>
<tr>
<td>Biotin</td>
<td>0.0025</td>
<td>0.0066</td>
<td>0.016</td>
<td>0.026</td>
<td>0.014</td>
</tr>
<tr>
<td>Inositol</td>
<td>—</td>
<td>122</td>
<td>927</td>
<td>640</td>
<td>428</td>
</tr>
<tr>
<td>Choline</td>
<td>71.3</td>
<td>108.0</td>
<td>127.9</td>
<td>203.1</td>
<td>113.4</td>
</tr>
<tr>
<td>Carotenes</td>
<td>trace</td>
<td>0.013</td>
<td>0.42</td>
<td>0.12</td>
<td>0.095</td>
</tr>
<tr>
<td>Tocopherols</td>
<td>trace</td>
<td>1.31</td>
<td>14.92</td>
<td>8.73</td>
<td>6.29</td>
</tr>
</tbody>
</table>

The results attained offer a complete view for the vitamin contents of the Italin rice "Originario" and of its by-products, thus giving positive ground to a
certain comparison with other varieties of rice and to their utilisation in the nutritional field.

SUMMARY

The thiamine, riboflavin, pyridoxine, B12 activity, nicotinamide, calcium pantothenate, biotin, folic acid, inositol, and choline contents of Italian rice “Originarrio” and of its by-products (bran, germs, polishings) were determined and shown in a table.

ACKNOWLEDGEMENT

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REFERENCES

2. Ibid. p. 54.
4. Ibid. p. 79.
5. Ibid. p. 46.
6. Ibid. p. 57.
7. Ibid. p. 63.
11. Ibid. p. 218.