Influence of palm oil and palm oil fractions on protein utilisation

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The influence of dietary palm-oil fractions on protein utilisation has been investigated in the growing rat. At 30 days of age, 4-6 groups of four rats were offered one of six semi-purified diets that differed only in the palm-oil fraction. Diet contained 200 g casein, 550 g carbohydrate, and 200 g fat/kg. The different palm-oil fractions were: crude palm oil (CPO), refined palm olein (RO), refined palm stearin (RPS), refinery palm olein (RPO), refined palm stearin (RPS), and refined palm olein (ROL). The control group was given Olive Oil (O) as the dietary fat source. The average efficiency of dietary protein was assessed as first Protein Utilisation (NPu), using a 10-day growth curve technique.

Weight gain and food intake were not altered by the various palm-oil fractions. However, the NPu for one RPO was significantly higher (p<0.05) than that of the rats given all other palm-oil fractions or the O control. It is concluded that the RPO has the potential to improve NPu in the rat, compared to four other palm-oil fractions as well as olive oil.

Despite the conflicting reports and possible influence of fat on growth, the general consensus among researchers has been to accept that the chief function of fat is as an energy source and thereby only influence the protein-energy ratio of the diet. However, a preliminary study by our group has indicated that the efficiency of protein utilisation (NPu) may indeed be influenced by the fat source. Palmitic was observed to give a higher NPu value than butyrate, stearate, and oleate.

Materials and methods

Weanling male (21-23 days old) Sprague-Dawley rats (OLAC Ltd, Shaw Farm, Blackthorn, Oxford, UK) were kept in a room maintained between 26-28°C with a 12 hour light and dark cycle. All animals were allowed free access to food and water.

Rats were fed the BP (Witam, Essex, UK) stock diet for 7 days prior to the NPu assay. At 30 days of age they were divided into groups of 4 and offered one of 6 semi-purified diets that differed only in the palm oil fraction. The composition of the diet is given in Table 1 (Diet P). The fat source of each of the semi-purified diets was as follows: crude palm oil (CPO), refined palm kernel (RKO), refined palm olein (RPO), refined palm stearin (RPS), and refined palm olein (RPO). A 7th control group was offered an identical diet but with olive oil (O, control) as the source of fat. Two further dietary groups were fed free-protein diets (Diet P, Table 1), with either refined olein (RPO) or crude palm oil (CPO) as the fat source.

The metabolisable energy content of the diets were calculated to be 20.15 kJ/g (or 20.15 kcal/g), by applying the conversion factors of 17.0, 37.0 and 17.0 kcal/g respectively for the energy content of protein, fat, and carbohydrate.

Groups of rats matched for body weight were killed at start of the experimental period, to provide an initial value of total body nitrogen content. During the next 10 days (the duration of NPu assay), each group was housed in a cage with wire mesh at the bottom. The split food was collected on a plastic tray covered with filter paper and kept underneath the cage. The powdered diet was dispersed in glass food pots. Energy and protein (nitrogen) were calculated as:

Energy = Weight gain x heat increment
Protein = Body weight gain x protein content

A preliminary report of this work was presented at the Proceedings of the Nutrition Society: BMBEN meeting, Eastbourne, 1995

Discussion

The dietary palm-oil fraction did not influence the amount of food consumed by experimental animals. Thus, feed palatability was not a factor influencing protein retention.

The fact that weight gain was also similar in all the groups tested. A similarity in the growth rate of rats fed on diets containing either CPO or RPO was also noted by Manorama and Rokmini.

The NPu in the RPO-fed groups was enhanced on average by about 13.3% compared to animals fed on any of the other 4 palm-oil fractions. It is well known that the relative proportions of saturated to unsaturated fatty acids (s/u) are the main determinants of an oil's physical and biochemical properties. As compared to the other 4 palm-oil fractions, palm olein has the highest s/u ratio (1.23 compared to 1.05, 0.57, 0.23, for RPO, RPS, and P respectively).

The digestibility of crude growing pigs has been shown to improve exponentially as a function of s/u.

Digestibility of oils can exert an influence on NPu. Although, nitrogen retention did show a slight improvement in RPO-fed groups, the increase was not statistically significant.

More recently Abe et al. reported that different palm-oil saturated fatty acids can exert differential effects on various lipid parameters in the rat. Whether the same could be said for protein metabolism is still to be investigated.

Manorama and Rokmini measured NPu in weaning Wistar rats fed on 10% of either CPO or RPO for 28 days. They could not find any significant difference in NPu between the two oils.

Furthermore, the mean NPu values they reported for the CPO-

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Table 1. Composition of semi-purified diets

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Diet basis (g/kg)</th>
<th>Energy (kJ/g)</th>
<th>Protein (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palm oil fraction</td>
<td>200</td>
<td>7400</td>
<td>36.7</td>
</tr>
<tr>
<td>Olein</td>
<td>200</td>
<td>7400</td>
<td>36.7</td>
</tr>
<tr>
<td>Stearin</td>
<td>200</td>
<td>3400</td>
<td>16.9</td>
</tr>
<tr>
<td>Sucrose/Conc-mei</td>
<td>250</td>
<td>9350</td>
<td>46.4</td>
</tr>
<tr>
<td>(8.3)</td>
<td></td>
<td></td>
<td>750</td>
</tr>
<tr>
<td>Vitamin and mineral mix</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P, vitamin</td>
<td>750</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Efficiency of protein utilisation. This was calculated using the formula for Net Protein Utilisation (NPu) described by Miller and Bender.

NPu = (B/Bo) x 100

Where B = body nitrogen of test diet fed group
Bo = body nitrogen of non-palm fed group
1 = nitrogen intake of test group

Statistical analysis

Differences between the dietary groups were analysed using one-way analysis of variance (ANOVA). Results are expressed as the mean and its standard deviation.

Results

Growth rate of animals fed on protein-containing diets was not significantly altered by the source of dietary palm-oil fraction nor by palm oil compared to olive oil (Figure 1). The food intake of rats was similar on all the protein-containing diets, as was the amount of nitrogen retention (Table 2).

The NPU of rats fed the diet containing refined palm olein was significantly higher (P<0.05) than all the other palm oil fractions and the olive oil control (Figure 2).

A preliminary report of this work was presented at the Proceeding of the Nutrition Society: BMBEN meeting, Eastbourne, 1995

Figure 1. Growth curve of rats fed on diets containing various palm oil extracts: CPO (c), RPK (D), RPO (E), RPS (A), ROL (P), F (F) CPO (O) and OO (O) as control. For details of dietary treatment, see Table 1. Points are means of 4-6 trials.

Figure 2. NPU for rats fed on various palm-oil fractions and olive oil. Values are the means with SD (n = 4-6 trials each). Significantly different, ANOVA *P<0.05.
Influence of palm oil and palm oil fractions on protein utilisation

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The influence of dietary palm oil fractions on protein utilisation has been investigated in the growing rat. At 30 days of age, 4 groups of 6 rats were offered one of six semi-purified diets that differed only in the palm-oil fraction. Diets contained 20% casein, 55% carbohydrate, and 20% fat. The different palm-oil fractions were: crude palm oil (CPO), refined palm oil (RPO), refined palm olein (RPO), refined palm stearin (RPS), refined palm olein (ROP), and the control group was given olive oil (OO) as the dietary fat source. The conversion efficiency of dietary protein was assessed as first Protein Utilisation (NPU), using a 10-day comparative carcass technique. Weight gain and food intake were not altered by the various palm-oil fractions. However, the NPU of one given RPO was significantly higher (p<0.05) than that of rats given all other palm-oil fractions or the control diet. It is concluded that the RPO has the potential to significantly improve NPU in the rat, compared to four other palm-oil fractions as well as olive oil.

Introduction

For more than a century, nutritionists have been concerned with the factors that affect protein utilisation. For example Wilcock and Hopkins1, showed that amino acid composition was a crucial factor influencing protein utilisation. The importance of energy intake in altering the efficiency of protein utilisation was first demonstrated by Fleck in 1979. It is now generally accepted that nitrogen balance is impaired when energy intake is inadequate3. The question of whether the type rather than the amount of non-protein energy is of any importance in affecting the utilisation of protein is less well resolved. Munro4, synthesized all these observations in a comprehensive review entitled "Carbohydrate and Fat Factors in Protein Utilisation and Metabolism". He concluded: "Thus nitrogen balance undergoes temporary impairment when fat is substituted for protein locally for dietary carbohydrate. Carbohydrates also play a special part in conserving protein of endogenous as well as of dietary origin, for the feeding of carbohydrate to fasting animal reduces nitrogen output but the feeding of fat does not have this effect until the fat stores are exhausted."

With the question of the superiority of carbohydrate or fat as an energy source for protein metabolism unresolved, another matter of interest was the impact of the type or nature of fat in particular on protein metabolism. Nutritional and co-workers5 reported no difference in growth in rats fed butter, maize, cotton seed, olive, groundnut, or soya oil. Whereas Thomasson6, who investigated 20 different oils, concluded that there was a difference in growth of rats fed various oils and noted that some oils in particular (rapeseed, kapokseed) produced extremely poor growth, similarly Naismith and Qureshi7 reported poor growth in animals fed mustard oil. Such effects, however, are difficult to interpret in terms of protein metabolism. While poor growth (weight gain) for reducing nitrogen-balance, the poor weight gain can also result from changes in food intake, with the efficiency of nitrogen utilization being unimportant. Another cause for poor growth may be an increased energy expenditure, or a fall in food intake such that the efficiency of nitrogen utilization is reduced it is a secondary effect to energy restriction8,9.

A preliminary report of this work was presented at the Proceedings of the Nutrition Society: :B2BEN meeting, Eastbourne, 1995

| Ingredient | Dietary basis (g/24 h) | Energy (kcal/24 h) | Protein (g/24 h) | NPU | RPS | RPO | ROP | RPS

| Palm oil fraction | olive oil | 200 | 7400 | 46.7 | 200 | 200 | 130 | 130 | 130 |
| Cassein | 200 | 3400 | 16.9 | 200 | 200 | 130 | 130 | 130 | 130 |
| Sucrose/Corn-mali | 550 | 9350 | 46.6 | 750 | 750 | 550 | 550 | 550 | 550 |
| Vitamin and mineral mixa | 50 | - | 50 | - | - | - | - | - | - |

P, protein; +, adequate; -defficient. Palm oil fractions purchased from Anygo Oils Ltd. King George Dock, Hull, UK. *Nutritional and vitamin mix obtained from IDE, Wixham, Beds, UK.

Analytical methods

Nitrogen content of carcass and food. The dried carcasses from each group were pooled and macerated. Samples of the finely minced carcass and of dried food were analysed for amino acid by the Kjeldahl method10,11.

Efficiency of protein utilisation. This was calculated using the formula for Net Protein Utilisation (NPU) described by Miller and Bend3, where NPU = (B/B-U) × 100

Where B = body nitrogen of diet fed group
B = body nitrogen of non-protein fed group
The purpose of this study is thus, to investigate the influence of dietary fat on protein utilisation, with specific reference to palm oil.

Materials and methods

Weaning male (21-23 days) Sprague-Dawley rats (OLAC Ltd, Shaw Farm, Blackthorpe, Oxon, UK) were kept in a room maintained between 26-28°C with a 12 hour light and dark cycle. All animals were allowed free access to food and water.

Rats were fed the BP (Wixham, Beds, UK) diet diet for 7 days prior to the NPU assay. At 30 days of age they were divided into groups of 4 and offered one of 6 semi-purified diets that differed only in the palm oil fraction. The composition of the diet is given in Table 1 (Diet P). The fat source of each semi-purified diets was as follows: crude palm oil (CPO), refined palm kernel (RKO), refined palm olein (RFO), refined palm stearin (RPS), and refined palm oil (ROP). A 7th control group was offered an identical diet but with olive oil (OO) control) as the source of fat. Two further dietary groups were fed on free-protein diets (Diet P, Table 1) with either refined olein (RFO) or crude palm oil (CPO) as the fat source. The metabolisable energy content of the diets were calculated to be 20.15 kcal/g (an air-dried basis), by applying the conversion factors of 17.0, 37.0 and 17.0 kcal/g respectively for the energy content of protein, fat and carbohydrate. Groups of rats (5 per group) were housed in a cage with wire mesh at the bottom. The spill food was collected on a plastic tray covered with filter paper and kept underneath the cage. The powdered diet was dispersed in glass food pots. Energy and protein (nitrogen) intake were calculated from the amount of air-dried food consumed multiplied by the nitrogen content of the diets, to give the nitrogen intake (g) (1) of the animals. On the 10th day of the assay period, the animals were killed by cervical dislocation. The water content of the carcasses (including gut contents) was determined by drying to a constant weight.

Table 1. Composition of semi-purified diets

Despite the conflicting reports and possible influence of fat on growth, the general consensus among researchers has been to accept that the chief function of fat is as an energy source and thereby only influence the protein-energy ratio of the diet. However, a preliminary study by our group has indicated that the efficiency of protein utilization (NPU) may indeed be influenced by the fat source. Palm oil was observed to give a higher NPU value than butter, sunflower, soya-, or olive oil.2 The purpose of this study is thus, to investigate the influence of dietary fat on protein utilisation, with specific reference to palm oil.

Efficiency of protein utilisation. This was calculated using the NPU = (B/B-U) × 100

Where B = body nitrogen of diet fed group
B = body nitrogen of non-protein fed group

Statistical analysis

Differences between the dietary groups were analysed using one-way analysis of variance (ANOVA). Results are expressed as the mean and its standard deviation.

Results

Growth rate of animals fed on protein-containing diets was not significantly altered by the source of dietary palm-oil fraction nor by palm oil compared to olive oil (Figure 1). The food intake of rats was similar on all the protein-supplemented diets, as was the amount of nitrogen retention (Table 2). However, the NPU of rats fed the diet containing refined palm olein was significantly higher (P<0.05) than all the other palm oil fractions and the olive oil control (Figure 2).

Discussion

The dietary palm-oil fraction did not influence the amount of food consumed by experimental animals. Thus, feed palatability was not a factor influencing protein retention.

The reduction of weight gain was also similar in all the groups tested. A similarity in the growth rate of rats fed on diets containing either CPO or RPO was also noted by Manoroma and Rokmini12.

The NPU in the RPO-fed groups was enhanced on average by about 13.3% compared to animals fed on any of the other 4 palm-oil fractions. It is well known that the relative proportions of saturated to unsaturated fatty acids (u/s) are the main determinants of an animal's physical and biochemical properties. As compared to the other 4 palm-oil fractions, palm olein has the highest u/s ratio (1.23 compared to 1.00, 0.57, 0.23, for RPO, RPS, and PRO respectively).7 The digestible energy in growing pigs has been shown to improve extensively as a function of u/s.10 Digestibility of oils can exert an influence on NPU.12 Although, nitrogen retention did show a slight improvement in RPO-fed groups, the increase was not statistically significant.

Figure 1. Growth curve of rats fed on diets containing various palm oil extracts: CPO ( ), RPO (D), RPS ( ), ROP ( ), F P ( ), CPF ( ) and OO ( ) as control. For details of dietary treatment, see Table 1. Points are means of 4-6 trials.

Figure 2. NPU for rats fed on various palm-oil fractions and olive oil. Values are the means with SD in 4-6 trials, and are significantly different, ANOVA × F; P<0.05.
表2. 重量摄入、能量摄入与氮平衡在不同食物中分布的数值

<table>
<thead>
<tr>
<th>食物类型</th>
<th>能量摄入 (g)</th>
<th>氮摄入 (g)</th>
<th>氮保留量 (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPO</td>
<td>258</td>
<td>29.2</td>
<td>11.1</td>
</tr>
<tr>
<td>RPO</td>
<td>236</td>
<td>19.9</td>
<td>10.5</td>
</tr>
<tr>
<td>RPO</td>
<td>260</td>
<td>44.1</td>
<td>10.6</td>
</tr>
<tr>
<td>RPO</td>
<td>244</td>
<td>55.4</td>
<td>10.6</td>
</tr>
<tr>
<td>RPO</td>
<td>240</td>
<td>37.0</td>
<td>10.2</td>
</tr>
<tr>
<td>RPO</td>
<td>255</td>
<td>34.1</td>
<td>10.6</td>
</tr>
</tbody>
</table>

平均体重增加约10.7磅

和RPO-甲鱼组分别是，13%的摄入量和8%的摄入量导致了不同的体重增加。RPO组的体重增加由肌肉增加和蛋白质的积累所导致。肌肉的形成由蛋白质的摄入所驱动。


Education and topology applied tocopherols accumulate in skin and protect the tissue against ultraviolet light-induced oxidative stress

Maret G Traber, Maurizio Podda, Christine Webster, Jens Thiele, Michalis Rallis, Lester Packer

Dept. Molecular and Cell Biology, University of California, Berkeley

To evaluate the tissue-specific distribution of lipophilic antioxidants including various vitamin E forms (tocopherols) and oxidized and reduced tocopherol and tocotrienol antioxidants, a microdissection procedure was used with high-performance liquid chromatography (HPLC). The tissue distribution was assessed by mass spectrometry (MS) and fluorescence detection (FD) techniques. The results indicate that the use of RPO enhances N balance and thus in theory, should improve tissue healing. A clinical trial with RPO as the fat component of the nutritional rehabilitation of malnourished children, may be a practical outcome of these studies.

Diet-derived and topically applied tocopherols accumulate in skin and protect the tissue against ultraviolet light-induced oxidative stress

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Introduction

The major lipophilic antioxidant in plasma, membranes and tissues is vitamin E. Vitamin E is the collective name for the 8 naturally occurring tocopherols and 4 tocotrienols, which exhibit vitamin E activity. Tocopherols differ from tocotrienols in that they have an isoprene instead of a phytyl side chain and they are present in plants and tocotrienols differ in the number of methyl groups on the chromanol nucleus (e.g.-3, 5, 7 and 9). Coenzyme Q (reduced form: ubiquinol, oxidized form: ubiquinone) also may play an antioxidant role in selected tissues (2-4). Lipid peroxidation is more efficiently than tocopherol in lipid deep lipids (5). A very sensitive method of detection is required for the quantification of these lipophilic antioxidants to determine their roles in protecting tissues against oxidative damage. We therefore, measured the tissue distribution of vitamin E by tocopherol and tocotrienol content from a tocopherol-rich palm oil fraction (TRF), and evaluated the protection conferred by these various forms of vitamin E against ultraviolet light-induced oxidative stress.

This paper reviews our recent findings concerning the tissue distribution of vitamin E antioxidants in hairless mouse tissues. We also present our findings on the protective effects of topical applied TRF to hairless mouse skin.

Materials and methods

Mammals were obtained from The Jackson Laboratory (34 MHz, 10% H2O, 2:10:80:15, 1:8:1). The HPLC was kindly provided by Palm Oil Research Institute of Asia Pacific J Clin Nutr (1997) 6(1): 63-77.

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