DEVELOPMENT AND EVALUATION OF NUTRI-BARS FOR INTERNALLY DISPLACED PEOPLE IN HUMANITARIAN EMERGENCIES

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ABSTRACT
This study was carried out at Institute of Food Science and Nutrition, University of Sargodha, Sargodha, Pakistan during 2012. The objective of study was to develop an easy to digest, instantly low cost and stable nutri-bars for IDPs (Internally displaced people) of humanitarian emergencies. Nutri-bars were developed from different ingredients in six different ratios. These bars were analyzed for physico-chemical, microbiological and sensory characteristics. Maximum moisture content (16.35%) was observed in T0 (dried apricot paste 12g, dry milk powder 1g, coconut 0.5g, cinnamon 0.5g, cardamom 0.5g, pepper 0.25g, fennel 0.25g, apricot kernel 0.5g, jaggery 2g and chocolate 2g) and maximum crude protein content (9.45%) in T2. Addition of barley, dried pumpkin and egg white increased the protein contents of nutri-bars. Similarly, crude fiber ranged from 5.47 to 6.37% in treatments T2 and T3 while ash contents ranged from 3.11% to 3.50% for T1 and T0, respectively. Nitrogen free extract (64.69%) was significantly affected due to addition of cereals along with apricot in different bars. The maximum gross energy value (339.615 kcal/100g) was recorded in treatment T2 (dried apricot paste 8g, roasted barley & chickpea powder and puffed rice powder 1.5g each, dried pumpkin powder 0.25g, dried egg white powder 0.25g, dry milk powder 1g, ground cinnamon and cardamom 0.5g each, pepper and fennel 0.25g each, coconut 0.5g, jaggery 2g and chocolate 2g). In sensory evaluation treatment T2 was ranked best regarding sensory characteristics like color, flavour, taste, mouth feel, texture and overall acceptability. It can be concluded from the results that the nutri-bars are good source of energy and nutrition for IDPs.

KEYWORDS: Disasters; IDPs; emergency food; nutri-bars; Pakistan.

INTRODUCTION
Disaster is a crisis situation that far exceeds the capabilities. Both, natural disasters which include floods, earth quakes, volcanoes, tornadoes, 

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hurricanes, epidemiology, and famine, and man-made disasters which include forest fires, explosions, internal wars, wars at borders and terrorism can cause extensive damages on earth (13). Emergencies are the result of any disaster, either it is natural or man-made and are characterized by the hap-hazard conditions of resultant stress and instability (6). Both, single disaster or a series of disasters could lead to the state of emergency. In emergency internally displaced persons (IDPs) require main three humanitarian necessities i.e. food, water shelter and clothing, needs are the first-aid and medicines.

Certain foods which were and still part of the emergency food programmes are grouped as whole foods, blended foods and powdered foods which include, wheat and wheat products, cereal and soya foods, corn soya blend (CSB), wheat soy blend (WSB), feed grains, corn meal, pulses, rice, beans, lentils (dal moong, masoor), dried gram flour, peas, corn, wheat flour, vegetable oil, high energy biscuits, dry milk powder and very less meat, fish and fat (10). Wawa mum food was given to IDPs by World Food Programme (WFP). It is 50 g mineral and vitamin-fortified paste meeting daily nutrient requirements and derived from locally-sourced chickpea with addition of honey packaged in sachet. It was manufactured in Faisalabad (15).

Keeping in view the above mentioned reasons the present research was planned to develop an easy to digest, instantly, low cost and stable nutri-bars during emergency/disaster circumstances.

**MATERIALS AND METHODS**

This study was carried out at Institute of Food Science and Nutrition, University of Sargodha, Pakistan during 2012. Black pepper, cinnamon, chickpea, dried apricots, dried milk powder, egg white, fennel, grated coconut, jaggery, puffed rice, barley, pumpkin, chocolate and small cardamom were procured from the local market of district Sargodha. Dried apricots were washed, dewatered and steamed for 3 minutes. Kernels of apricots were then removed. Barley was roasted on hot plate until slightly brown color appeared. Apricot kernels, black pepper, cinnamon, cardamom, egg white, fennel, pumpkin, puffed rice, chickpea (roasted) and barley were ground to form powder. Jaggery was crushed to provide ease in procedure of mixing and dough forming.

**Preparation of nutri-bars**

Nutri-bars were prepared according to the method described by Nadeem *et al.* (13). Dried apricot paste was prepared by using mincing machine. After
preparation of raw materials, dried apricots paste was taken in a mixer and other ingredients were mixed thoroughly to distribute uniformly. After mixing, dough was divided into medium sized balls and then sheeting was done by adding dry milk. Nutri-bars of 2 cm width, 1 cm height and 6cm in length were cut from sheet of dough. Each nutri-bar weighed approximately 20±1 g. These were then placed into aluminium foils and were kept at room temperature (20±5°C). Treatment plan of nutri-bars is given in Table 1. The quantities of some ingredients were used in different proportions and combinations while some were kept constant.

Table 1. Formulation of nutri-bars.

<table>
<thead>
<tr>
<th>Ingredients (in grams)</th>
<th>T0</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dried apricot paste</td>
<td>12</td>
<td>8</td>
<td>8</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Roasted barley powder</td>
<td>0</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>0</td>
<td>1.5</td>
</tr>
<tr>
<td>Roasted chickpea powder</td>
<td>0</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>0</td>
<td>1.5</td>
</tr>
<tr>
<td>Puffed rice powder</td>
<td>0</td>
<td>1.5</td>
<td>1.5</td>
<td>0</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Dried pumpkin powder</td>
<td>0</td>
<td>0</td>
<td>0.25</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dried egg white powder</td>
<td>0</td>
<td>0</td>
<td>0.25</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dry milk powder</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Cinnamon (ground)</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Cardamom (ground)</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Pepper (ground)</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Fennel (ground)</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Apricot kernel (ground)</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Jaggery (ground)</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Coconut grated</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Chocolate</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Physical analysis

Water activity (aw): Water activity in nutri-bars was determined by the electronic hygropalm water activity meter (Model Aw-Win, Rotronic, equipped with a Karl-Fast probe). It was first calibrated and bars were analyzed (12).

Instrumental texture analysis: Instrumental texture of the nutri-bars was determined with the help of texture analyzer (Model TA.XT plus, Stable Microsystems, Surrey, UK) with 5 kg load cell. The texture expert program version 4.1.2 was used for data analysis. Texture determination was made by using a 3 point bend rig for a bend test (13).

Color measurement: Color of nutri-bars was determined with the help of color meter (colortest II, Neohuauas Neotec) (12). The color meter was calibrated with standards 151 CTn (light color) and 54 CTn (dark color). The samples were placed centrally under photocell of color meter. The reading of color meter was compared with that of standards.
Chemical analysis

Proximate composition: The proximate composition such as moisture, crude protein, crude fiber, crude fat, ash and NFE of nutri-bars was determined and expressed on dry matter basis according to the procedures given in AOAC (4).

Gross energy value: The gross energy of the best nutri-bars was calculated using standard factors for energy in the form of kcal/g as 4, 9 and 3.75 kcal/g for protein, lipid and carbohydrate, respectively. The energy contents were summed up to give total or gross energy (9).

Microbiological analysis: Total plate count (TPC) and mold count (MC) of nutri-bars were determined according to the procedures given in AOAC (4).

Sensory evaluation: Nutri-bars were evaluated for sensory characteristics such as color, flavor, texture and overall acceptability at room temperature in sensory evaluation laboratory by a panel of ten untrained judges on 9-point Hedonic Scale (8).

Results were statistically processed using analysis of variance technique. The difference in means was evaluated by LSD test (17).

RESULTS AND DISCUSSION

Physical analyses

Water activity of nutri-bars: The means of water activity for different treatments ranged from 0.567 to 0.536 having lowest score for T₅ and highest score for T₀. There was a gradual decrease in water activity with decreasing concentrations of apricot paste in different treatments (Fig. 1). The results of water activity for various treatments is in accordance with the findings of Rehman et al. (14) who reported the water activity from 0.546 to 0.534 in apricot date bars.

Color measurement of nutri-bars: The means of color for different treatments varied from 127.75 CTn to 103.16 CTn having lowest mean value for T₅ and highest mean for T₀ (Fig. 2). There was a gradual increase in color values with decreasing percentage levels of apricot paste. The higher color values indicate light color, whereas lower values indicate dark color. The color for various treatments is in conformity with the findings of Rehman et al. (14) who reported the color values range from 129.62 to 127.86 in apricot date bars.

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Texture of nutri-bars: Firmness of bars was described in terms of maximum force (g). The means of hardness for different treatments ranged from 742.12 g to 436.47 g (Fig. 2). This reveals that T₅ had more hardness and it gradually decreases towards T₀. There was a gradual increase in hardness with decreasing concentrations of apricot paste. The value of texture for various treatments is in conformity with the findings of Rehman et al. (14) who reported the hardness (firmness) from 315.58 to 420.52 g in apricot date bars.
Chemical characteristics of nutri-bars

**Proximate composition of nutri-bars:** The mean values for the moisture contents of nutri-bars ranged from 11.04±0.13% (T₂) to 16.35±0.23% (T₀). The maximum moisture (16.35±0.23%), crude fiber (6.37±0.03%) and ash content (3.50±0.02%) were found in T₀. The maximum crude protein content (9.45±0.12%) and maximum crude fat content (6.86±0.01%) were observed in T₂ and the minimum crude protein value (5.48±0.06%) was found in T₀. The maximum NFE (carbohydrates) value (64.69±0.15%) and the minimum ash value (3.11±0.01%) was found in T₁ (Table 2).

Table 2. Mean values ± SD for proximate composition of nutri-bars.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Moisture (%)</th>
<th>Crude protein (%)</th>
<th>Crude fiber (%)</th>
<th>Crude fat (%)</th>
<th>Ash (%)</th>
<th>NFE (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₀</td>
<td>16.35±0.23A</td>
<td>5.48±0.06F</td>
<td>6.37±0.03A</td>
<td>5.59±0.20D</td>
<td>3.50±0.02A</td>
<td>61.70±0.18F</td>
</tr>
<tr>
<td>T₁</td>
<td>11.42±0.18C</td>
<td>8.24±0.04B</td>
<td>5.65±0.03E</td>
<td>6.86±0.15A</td>
<td>3.11±0.01C</td>
<td>64.69±0.15A</td>
</tr>
<tr>
<td>T₂</td>
<td>11.04±0.13D</td>
<td>9.45±0.12A</td>
<td>5.47±0.06E</td>
<td>6.86±0.01A</td>
<td>3.13±0.05C</td>
<td>64.02±0.20C</td>
</tr>
<tr>
<td>T₃</td>
<td>13.57±0.15B</td>
<td>7.69±0.15C</td>
<td>6.21±0.01B</td>
<td>6.47±0.05B</td>
<td>3.29±0.01B</td>
<td>62.74±0.13E</td>
</tr>
<tr>
<td>T₄</td>
<td>13.57±0.15B</td>
<td>6.29±0.02E</td>
<td>5.89±0.05C</td>
<td>6.44±0.01B</td>
<td>3.25±0.01B</td>
<td>64.54±0.06B</td>
</tr>
<tr>
<td>T₅</td>
<td>13.57±0.10B</td>
<td>7.32±0.01D</td>
<td>5.75±0.02D</td>
<td>6.38±0.02C</td>
<td>3.35±0.03B</td>
<td>63.53±0.04D</td>
</tr>
</tbody>
</table>

Values with different letters in column each differ significantly (P<0.05).

Amount of moisture is dependent on amount of dried apricot utilized. It is clearly indicated from the results that there was a gradual increase in moisture contents with increasing concentration of dried apricot paste in bars and vice versa. There was a gradual increase in protein contents with increasing concentrations of roasted gram in nutri-bars and decrease with decreasing concentrations of roasted gram. Chickpea contains about 72% carbohydrates, 1.80% crude fat, 5.2% crude fiber, 20.2% crude protein and 1.8% ash (11). Moreover maximum value of crude protein in nutri-bars (T₂) may be due to utilization of egg white powder and dried pumpkin powder that are good source of protein. Dried apricots are low in crude protein content, therefore its maximum quality used in bars (T₀) resulted in minimum protein value. Similarly, ash contents increased with increasing the concentrations of dried apricot paste in nutri-bars. The NFE (carbohydrates) contents of nutri-bars increase with increasing amount of dried apricot paste. The maximum amount of NFE contents were in T₁ because it has combination of rich carbohydrate cereals and dried apricot paste. The results regarding the proximate composition of nutri-bars are in close agreement with the findings of Rehman et al. (14).

**Gross energy value:** Using standard factors of 4, 9 and 3.75 kcal/g for protein, lipid and carbohydrate, respectively the energy contents were
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summed to give total or gross energy of the nutri-bars (9). Energy calculation of nutri-bar T2 is given below:

1 plain nutri-bar provides 9.45% protein, 6.86% fat and 64.02% NFE.

1 g protein provides energy = 4 kcal
9.45 g protein provides energy = 4 x 9.45 = 37.80 kcal
1 g fat provides energy = 9 kcal
6.86 g fat provides energy = 9 x 6.86 = 61.74 kcal
1 g NFE provides energy = 3.75 kcal
64.02 g NFE provides energy = 3.75 x 64.02 = 240.075 kcal
Total energy provided by nutri-bars of 100g

Microbial analysis

Total plate count (TPC) of nutri-bars: The mean values for TPC of nutri-bar samples (Fig. 3) vary from 3.27 to 3.23 Log10 cfu/g. The maximum value was observed in T3 (3.23 Log10 cfu/g). It is evident from the results that there is a significant difference in TPC within different treatments. The results of this study are strengthened by the earlier findings of Al-Hooti et al. who observed that TPC significantly varied from 1.00 to 2.18 Log10 cfu/g in date bar samples (1).

Total mold count of nutri-bars: The mean values for mold count of nutri-bar samples ranged from 2.77 to 2.88 Log10 cfu/g having the maximum count

Fig. 3. Mean values for total plate count (log10 cfu/g) of nutri-bars.

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(2.88 Log$_{10}$ cfu/g) for T$_0$ and minimum count (2.77 Log$_{10}$ cfu/g) in T$_1$ (Fig. 4). It is evident from the results that there is a significant difference in mold count in treatments. The results of mold count are strengthened by the early findings of Al-Hooti et al. who observed that mold count varied significantly in date bars from 2.6 to 3.00 Log$_{10}$ cfu/g (1).

Sensory Evaluation

All the treatments were liked by the judges, but the maximum mean color score (7.92), flavour score (7.36), taste score (7.56), mouth feel (7.40), texture score (7.40) and overall acceptability value (7.56) was achieved by treatment T$_2$ (Fig. 5).
CONCLUSION

It is concluded from above results that all treatments containing different concentrations of dried apricot paste, roasted black gram and barley, puffed rice, constant quantities of black pepper, cardamom, cinnamon, coconut, fennel, dried milk powder, jaggery and chocolate were found acceptable but T2 was found to be the best among different treatments. These nutri-bars will prove healthy food product in terms of nutrient and energy for IDPs of humanitarian emergencies and should be developed within Pakistan at commercial level. The ingredients utilized are all indigenous and available round the year. Ingredient choice intention was to cope with malnourishments, mental and emotional stress which seems to be fulfilling.

REFERENCES


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Industry/UN-chick-pea vitamin - paste - battling - malnutrition - in - Pakistan.
