

Nutritional and Health Benefits of Peanut (*Arachis Hypogaea*)-based Therapeutic Foods as Well as its Effects on Child Health Services Delivery in North-West Nigeria

Mohammed I. Abubakar^{1*}, Umar A. Ahmad²

¹Department of Primary Health Care, Ministry of Health Hail, Kingdom of Saudi Arabia

²Department of Community Medicine, Ahmadu Bello University Zaria, Nigeria

Abstract

Hunger and malnutrition are some of the pressing challenges facing the health systems in the developing world today, and more innovative interventions are needed as a solution to these challenges. The aim of this study is to identify the nutritional and health benefits of peanut-based therapeutic foods in children suffering from malnutrition and assess the effects of this specific therapeutic food on the outcomes of child health services delivery in North-West Nigeria. A cross-sectional survey was conducted to measure multiple factors and identify the nutritional and health benefits of peanut-based therapeutic foods and assess its acceptability among individuals and families of malnourished children in North-West Nigeria. The effects of PBTF on the delivery of child health services in Sabon Gari Local Government Area in Kaduna state, North-West Nigeria. A total of 396 (97.5%) of mothers and caregivers believe that PBTF is making their child better. Up to 305 (75.1%) reported that the general health of their child has improved and 77 (19%) said their child gained weight, 13 (3.2%) reported that their child's appetite has increased while 8 (2%) had noticed an increase in the activity of the child. Most respondents (96.5%) believe eating peanuts alone or with food is beneficial to their health. In conclusion, Peanut-Based Therapeutic Foods have valuable nutritional and health benefits and PBTF drives the performance of child health services delivery in North-West Nigeria.

Keywords: Child health Services Delivery, Malnutrition, Peanut-based therapeutic food, Ready-to-use therapeutic foods.

Introduction

Peanut (*Arachis hypogaea* L.) is an oil-seed legume that has been described as a multipurpose plant because of its many benefits [1, 2]. Its nutritional and medicinal benefits have been reported by earlier studies [1, 3]. Scientists have identified bioactive components present in peanuts and these include phenolics, flavonoids, polyphenols, and resveratrol [1, 3], [4]. The nutritional components of peanuts are in their most beneficial form. Protein is plant-based, the fat is unsaturated, and the fiber is a complex carbohydrate. These forms have been shown to be of the best value in human

nutrition [4]. The fat in peanuts have been described as heart-friendly due to its content of 50% monounsaturated fatty acids (MUFAs), 33% paraformaldehyde (PFA), and 14% saturated fatty acids [3, 4]. Raw peanuts, peanut butter, and peanut oil have been shown to reduce body cholesterol and support heart health. Studies have linked nut intake with a reduced risk of coronary heart disease due to the high levels of monounsaturated fat [4, 5]. Peanut fat also provides calories to children and infants suffering from malnutrition [4, 5].

Hunger and malnutrition are some of the pressing challenges facing the health systems in

Received: 20.05.2022

Accepted: 10.06.2022

Published on: 30.09.2022

*Corresponding Author: muhabui2005@yahoo.co.uk

the developing world today, and more innovative interventions are needed as a solution to these challenges. The effects of malnutrition are more pronounced in children, especially those below the age of five, and ready-to-use therapeutic foods (RUTFs) were developed to help severely malnourished children living at home as well as those in the hospital [6]. One of such interventional option of RUTF is a combination of peanut butter, dried skimmed milk, vitamins, and minerals, and it was readily accepted by the target individuals [6, 7]. This research intends to find out the nutritional and health benefits of peanut-based therapeutic food and its effects on the performance of child health services delivery in the Northwest region of Nigeria.

Literature Review

Peanut (*Arachis hypogaea* L.), also known as groundnut, was said to have a South American origin but is now grown worldwide, in tropical and sub-tropical regions of Africa, Asia, and the Americas as a seasonal legume [1, 2, 4]. A peanut is biologically a pea belonging to the Fabaceae family of bean/legumes but because of its high content of oil, it is considered an oil seed [4]. Studies have reported peanut's high nutritional value due to their rich contents of protein, oil, and fibers [4, 5, 8, 9, 10]. It is an important legume that has been used to produce oil, and it can be added to different types of cuisines to increase the nutritional value of food due to the high-quality nutritional materials it contains such as proteins, fibers, polyphenols, antioxidants, vitamins as well as minerals [4, 6, 8, 9].

Snacks and confectioneries such as roasted peanuts, meat products, peanut butter, soup or some desserts all contain peanuts. Peanut also contains resveratrol, phenolic acids, flavonoids, and phytosterols, which inhibit cholesterol absorption from the diet [4, 8, 9, 11]. Other valuable materials contained in peanuts include co-enzyme Q10 and many amino acids as well as a high amount of arginine. The presence of

bioactive compounds in peanut confers it with medicinal properties that help in the prevention of diseases and health promotion [7]. Peanut has been used as a component of foods used for the management of malnutrition in malnourished children in Africa [4, 6, 7, 11].

The protein in peanuts is more than that found in other nuts and sometimes better than the protein in beans servings. Scholars have reported that the protein content in peanut cake after the oil has been extracted, can reach 50 percent [2, 4, 7, 10, 12]. Peanut is the largest source of the protein arginine, and peanut proteins are said to be equivalent to meat and eggs based on nutritional value [4, 10, 13, 14]. Peanut protein is being used in the food industry to produce high-protein food due to its emulsifying activity, solubility, and water retention [4, 10, 15]. This is also the reason why it is being added to infant food formulas.

The fiber in peanuts contains sucrose and starch as well as other reducing sugars, and this is why peanuts have a low glycemic index: the carbohydrate in peanuts leads to a slower rise in blood sugar [4, 7, 13, 14]. Peanut is also an excellent source of vitamins that include vitamin A, E, niacin, riboflavin, thiamin, folate, pyridoxine and pantothenic acid [7]. It also supplies minerals such as copper, manganese, iron, phosphorus, magnesium, selenium, and zinc [4, 7].

Health Benefits of Peanuts

Peanut oil is free from trans-fat, low in saturated fats, high in unsaturated fatty acids, and has no cholesterol [2, 4, 5, 13, 16, 17]. The health benefits of peanuts are numerous and include improving serum lipids profile as well as the reduction in the risk of cardiovascular disease leading to protection of the heart [4, 17]. It has also been suggested that peanut intake reduces the risk of colorectal cancer [2], [4]. Consumption of peanuts, especially with its skin, has been reported to provide an antioxidant activity that leads to long-term health benefits [2, 5]. Individuals that are eating

peanuts or peanut butter have been found to have lower blood pressure as well as reduced risk of death due to cardiovascular disease [4], [5]. The risk of diabetes was also reduced by a quarter in people who added peanuts to their diet daily [4, 16, 19].

Peanut-based therapeutic food as well as peanut milk are used in the treatment of malnutrition and have been shown to lead to rapid recovery of health. An example of peanut-based ready-to-use therapeutic food (RUTF) is the plumpy nut which has been used to fight severe malnutrition in Africa [4].

Peanut-based therapeutic food used in the treatment of severe and moderate malnutrition in children leads to faster recovery rates and shorter duration to reach weight-to-growth goals [4, 17]. The United Nations has approved the use of RUTF for the management of emergency cases of malnutrition and many nutritional programs have been delivered in developing countries using the peanut-based RUTF [18].

Methodology

Study Area

The study area was Sabon Gari Local Government Area of Kaduna State in the north-western region of Nigeria. Sabon Gari Local Government Area is one of the 23 LGAs of Kaduna State, located in the Northern Senatorial Zone. It has a boundary with Ikara, Makarfi, Giwa, Zaria, and Soba Local Governments in the north, northwest, west, south, and east, respectively. It covers a land area of about 60,000 square kilometers and has a projected population of 322,874 (2006 census). The LGA comprises a heterogeneous mix of tribes, a preponderance of Hausa and Fulani amidst Yoruba, Igbo, Gwari, and others. The predominant occupations of the people are farming, trading, and civil service, while Islam and Christianity are the main religions practiced by them.

Sabon Gari LGA has 58 health facilities in its 11 political wards and 6 districts which are

overseen by three hundred and thirty-two (332) staff of the Primary Health Care (PHC) Department. Among these facilities, 33 are government owned, while 25 are private. The PHC Department has various units, among which is the Disease Control Unit which also has three divisions: water, sanitation, and food hygiene.

There are many street-food vendors hawking different kinds of foods and food materials in almost all the streets, but there are no records of their number and or activities in the Health Department of the LGA. However, there are twenty-three (23) registered food establishments (restaurants) in the LGA, and the staff of the Disease Control Unit carries out a routine inspection of these establishments quarterly, but additional inspection may be carried out when disease outbreaks such as cholera occur.

Study Design

A cross-sectional descriptive study design was used for this research.

Study Population

The study population included all the mothers or caregivers of under-five children living in the study area.

Inclusion Criteria

1. Mothers or caregivers of under-fives who have ever used a peanut-based therapeutic diet.
2. Mothers or caregivers of under-fives who have ever used a peanut-based therapeutic diet and living in the study area.

Exclusion Criteria

1. Mothers or caregivers of under-fives who have ever used a peanut-based therapeutic diet but were not present during the data collection.
2. Mothers or caregivers of under-fives who have ever used a peanut-based therapeutic diet refuse to give consent.

Sample Size Determination

The sample size was determined using the following formula.

$$n = \frac{Z^2 pq}{d^2}$$

Where:

n = minimum sample size.

z = standard normal deviation which corresponds to 95% confidence interval.

p = reported benefit of peanut consumption in reducing mortality due to any factor when peanuts were included as an integral part of the routine diet [5], [17] = 40% = 0.40.

q = 1 – 0.40 = 0.60.

d = degree of precision = 5% = 0.05.

$n = \frac{(1.96)^2 \times 0.40 \times 0.60}{(0.05)^2} = 368.79$

n = 369.

Adding 10% non-response rate to the minimum sample size = 369 + 36.9 = 405.9.

Hence, the final minimum sample size is 406.

Sampling Technique

A multistage sampling technique was used in selecting respondents through the following stages.

Stage 1 (Selection of study area): selection of two LGAs was made using simple random sampling (SRS) by balloting from the list of 23 local government areas of Kaduna State. Then using a simple toss of coin, Sabon Gari was selected as the study LGA.

Stage 2 (Selection of wards): in each of the two selected LGAs, a list of all (22) political wards were drawn, and through SRS by balloting, two political wards were selected.

Stage 3 (Selection of settlements): four settlements were selected from the list of settlements in every chosen ward using the SRS by balloting method.

Stage 4 (Selection of streets): five streets that were used were selected using SRS by balloting from the list of all streets in each selected settlement.

Stage 5 (Selection of households): Using SRS by balloting the number of mothers/caregivers that were studied were selected based on the proportion allocated for that street.

Study Instruments and Data Collection Methods

Data was collected using a pretested interviewer-administered structured questionnaire with closed-ended questions. Prior to data collection, five research assistants were trained for two days on the tools and data collection techniques that were used. The questionnaire was pretested in a different LGA from the study LGA, and some adjustments were made. Questionnaires were used to collect data from the mothers/caregivers of the under-fives on a one-to-one basis. The questionnaires covered these topics: (i) knowledge and attitude of patients about the role of peanut-based RUTF in their treatment; (ii) health outcome and nutritional status after consumption of peanut-based RUTF.

Statistical Analyses

The data obtained were entered, cleaned, coding done where necessary, and analysis was carried out using IBM SPSS statistics version 27. Results were presented in tables and charts. Summary statistics using mean, standard deviations and percentages were calculated for each quantitative variable, and the statistical significance of the relationship between variables was determined using chi-square test with a p-value of ≤ 0.05 .

Results and Discussion

Study Group Characteristics

Table 1 provides descriptive data on the four hundred and six participating mothers or caregivers. More than half of the 406 participants (58.4%) fell within the age range of '25 to 34' years old. And up to 87.4% were housewives with no specific occupation; however, there are civil servants, business

owners as well as students amongst the respondents. The median age of the participants was 31 years.

Table 1. Characteristics of the Respondents (n = 406)

| S/no. | Socio-demographic characteristic | | Frequency | Percent (%) |
|-------|----------------------------------|----------------|-----------|-------------|
| | Characteristic | Variable | | |
| 1. | Research Population | All Female | 406 | 100 |
| 2. | Age (years) | 18 – 24 | 41 | 10.1 |
| | | 25 – 34 | 237 | 58.4 |
| | | 35 – 44 | 125 | 30.8 |
| | | 45 – 54 | 3 | 0.7 |
| 3. | Occupation | Civil servant | 18 | 4.4 |
| | | Housewife | 355 | 87.4 |
| | | Business owner | 6 | 1.5 |
| | | Student | 6 | 1.5 |
| | | Unemployed | 21 | 5.2 |

Mothers’ and Caregivers Perceptions about PBTF

Most of the mothers and caregivers interviewed, 399 (98.3%) were aware of PBTF (Table 2), and more than half of the respondents (232 (57.1%)) have received PBTF from the community hospital some time ago. However, up to 170 (41.9%) of the respondents prepared PBTF locally at home. Of all the caregivers interviewed, 278 (68.5%) said that PBTF was

readily accepted by their children, while only 2 (0.5%) expressed that the child rejects it completely while 99 (24.4%) needed encouragement and 24 (5.9%) had to be forced. Almost all the mothers and caregivers (98.3%) said they had not noticed any side effects when they fed their child with PBTF but at least 5 (1.2%) attributed feeding PBTF with vomiting in their child.

Table 2. Knowledge about PBTF

| Heard about PBTF | Frequency | Percent % |
|------------------|-----------|-----------|
| Yes | 399 | 98.3 |
| No | 7 | 1.7 |
| Total | 406 | 100.0 |

Nutritional and Health Benefits of Peanut-Based Therapeutic Foods

However, with all the issues related to the acceptability and side effects of PBTF, 396 (97.5%) of mothers and caregivers still believe that PBTF is making their child better. Up to 305 (75.1%) reported that the general health of their child has improved (Table 5) and 77 (19%) said their child gained weight, 13 (3.2%) reported that their child’s appetite has increased, while 8 (2%) have noticed an increase in the activity of the child.

Most of the respondents (96.5%) believe that eating peanuts alone or with food is beneficial to their health (Table 4). Therefore, almost all the respondents (97%) have fed their children this therapeutic food at some point in their lives. Some of the participants (40.1%) said they were only following the instructions of their healthcare provider who prescribed PBTF for their sick child. On the other hand, some of the mothers only feed their children with PBTF because they believe it increases the child’s weight. Most of the mothers and caregivers, 358 (88.2%), perceive the benefits of peanuts

and PBTF to include the provision of energy, while 55.9% believe that it improves the taste of food and is a better source of protein (Table

3). Also, some of the respondents, 254 (62.5%) trust that eating peanuts or its oil improves the health of an adult.

Perceptions about the Benefits of PBTF

Table 3. Perceptions about the Benefits of Peanuts and PBTF

| Benefits of Peanuts and PBTF | Frequency | | | | Percent % | | | |
|--|-----------|-----|------------|-------|-----------|------|------------|-------|
| | Yes | No | Don't Know | Total | Yes | No | Don't Know | Total |
| Increase energy | 358 | 48 | 0 | 406 | 88.2 | 11.8 | 0 | 100 |
| Prevent diseases | 126 | 280 | 0 | 406 | 31.0 | 69.0 | 0 | 100 |
| Increase body oils | 141 | 265 | 0 | 406 | 34.7 | 65.3 | 0 | 100 |
| Improves taste of food | 227 | 179 | 0 | 406 | 55.9 | 44.1 | 0 | 100 |
| Source of proteins | 227 | 7 | 172 | 406 | 55.9 | 1.7 | 42.4 | 100 |
| Adults who eat peanuts or its oil have better health | 254 | 6 | 146 | 406 | 62.5 | 1.5 | 36.0 | 100 |

Table 4. Percentage Distribution of Belief that Eating Peanuts is Beneficial to Health

| Eating Peanuts is beneficial to Health | Frequency | Percent % |
|--|-----------|-----------|
| Strongly disagree | 7 | 1.7 |
| Disagree | 1 | .2 |
| Neutral | 6 | 1.5 |
| Agree | 288 | 70.9 |
| Strongly agree | 104 | 25.6 |
| Total | 406 | 100.0 |

PBTF Makes the Child Better

Table 5. Percentage Distribution of Benefits of PBTF to the Child

| Benefits of PBTF to the Child | Frequency | Percent % |
|----------------------------------|-----------|-----------|
| General health of child improves | 305 | 75.1 |
| Child's activity increased | 8 | 2.0 |
| Child gained weight | 77 | 19.0 |
| Appetite of child improves | 13 | 3.2 |
| Others | 3 | 0.7 |
| Total | 406 | 100 |

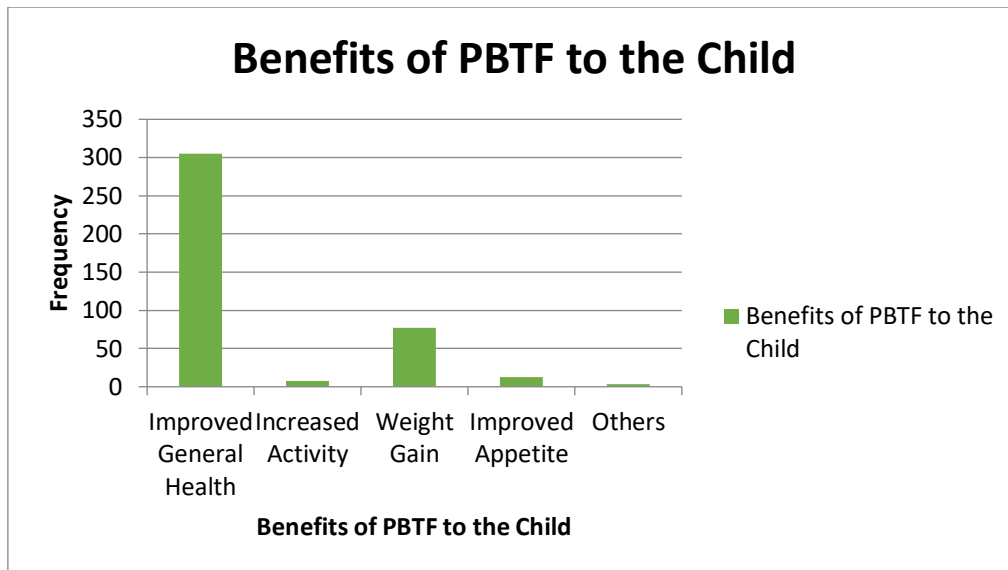


Figure 1. Benefits of PBTF to the Child

Discussion

This study examined the nutritional and health benefits of peanut-based therapeutic foods and its effects on the performance of child health services delivery in the Northwest region of Nigeria. The study found out that 96.5% of mothers and caregivers believe that eating peanuts alone or with food is beneficial to their health and 97% have fed their children Peanut-Based Therapeutic Food at some point in their lives. Also, 97.5% expressed satisfaction with PBTF where they confirmed that it is making their children better.

Regarding nutritional and health benefits of using PBTF, we found that the general health of most children had improved, as reported by 305 (75.1%) mothers and caregivers, and 77 (19%) said their child gained weight, 13 (3.2%) reported that their child's appetite has increased while 8 (2%) have noticed an increase in the activity of the child.

The presence of bioactive compounds in peanuts, such as flavonoid, provides it with the characteristic medicinal properties that help in the prevention of diseases and promote health [4]. The availability of these minerals in high quantities is an indication of the nutritional value of peanuts as well as its health benefits

since these micronutrients improve the quality of health of individuals [4, 6].

Peanut has been reported to contain the largest source of the protein arginine, and its proteins are said to be equivalent to meat and eggs based on nutritional value [2, 4, 10]. The fiber in peanuts helps to maintain normal blood sugar because it contains sucrose and starch as well as other reducing sugars [4]. These high-quality nutritional components of peanuts make peanut-based therapeutic food an effective means of treatment of severe and moderate malnutrition in children, and it leads to faster recovery rates and shorter duration to reach weight-to-growth goals [4].

It is not surprising that a high proportion of the respondents believe in the nutritional and health values of peanuts and PBTF because they have directly experienced these benefits either as individuals or have observed improvement in their children following the use of PBTF. This is in line with the findings in earlier studies that have reported that peanut-based food is used for the management of children suffering from malnutrition in Africa [4, 6]. Similarly, other studies have reported peanut's high nutritional value due to their rich contents of protein, oil, and fibers [4, 10]. Our study has also found out that peanut is used by people living in the study area as a source of

protein which supports the stance of other scholarly studies that have earlier shown that peanut contains proteins greater in amount than that seen in other nuts and beans serving. [4] and [10] have reported that up to 50 percent of the content in peanut cake is protein. These scholars have compared the protein in peanut as equivalent to that of meat and eggs based on nutritional value. Peanut is, therefore, a valuable source of food that, when used have the potential to improve the nutritional and health status of individuals. Also, because of this, high-protein therapeutic foods and infant formulae are being produced using peanuts due to its emulsifying activity, solubility, and water retention [2, 4, 10].

The acceptability of PBTF amongst the children at Sabon Gari Local Government Area (LGA) in Kaduna state is very high (68.5%) and almost all the mothers/caregivers (98.3%) have not noticed any side effects when they feed their children with the product. Even though, a small percentage of the respondents (1.2%) have reported vomiting as a side effect from eating PBTF. Also, our findings showed that PBTF was not accepted by about 30 percent of the children which agrees with the findings from the study of [7], that was carried out in Bangladeshi, which showed that 40% of the caregivers were dissatisfied with the PBTF due to its taste (too sweet or too salty) and consistency. Similarly, a study quoted in [7] conducted in Malawi also had reported that mothers complained about the taste of a type of PBTF. However, our study disagrees with [7] because they reported the presence of vomiting and diarrhea as side effects associated with PBTF intake in 60 percent of the children. Though, the authors later confirmed that they were unable to ascertain any direct relationship between PBTF intake and the reported side effects [7].

Another important finding is that most of the mothers/caregivers (97.5%) in Sabon Gari LGA of Kaduna state have shown satisfaction with PBTF because the therapeutic food is making

their children healthy. They have reported that there is improvement in the general health, body weight, appetite, and activity of their children following the intake of PBTF. This is proof that the use of PBTF as an intervention to fight hunger, improve nutritional status and improve the health of children is succeeding. Hunger and malnutrition are some of the serious challenges that the health systems in the developing world are struggling with [6]. Our findings are suggestive that PBTF use is positively affecting the performance of the child health services delivery in the North-West region of Nigeria. PBTF improves the quality of the child health services delivery which leads to the high levels of satisfaction (97.5%) shown by the mothers/caregivers of children in Sabon Gari LGA in North-West Nigeria. High quality services have been shown to directly impact the performance of healthcare organizations and the health system in general [19], [20]. Also, PBTF as an intervention improves the effectiveness of the child health services delivery by accelerating the achievement of the main goal of the health system of improving the health of the population and, in this case, the health of the children in the region.

One of the limitations of this study is the fact that mothers and caregivers of children were assessed about their perception of PBTF and even though this indirectly assessed the perception of their children but still it might not accurately reflect what the children themselves perceived. Regardless of all these perceived limitations it is encouraging that at least 96.5% mothers/caregivers believed that PBTF had therapeutic benefits for malnourished children.

Conclusions and Recommendations

The study has shown that Peanut-Based Therapeutic Food have valuable nutritional and health benefits and PBTF drives the performance of the child health services delivery in North-West, Nigeria. We recommend that government and other stakeholders in the health sector should use this

opportunity to develop peanut-based products that will be accessible widely to poor communities as a strategy to improve nutritional and health status of the population.

Authors' Statements

Authors' Contributions

MIA conceived the study; UA designed the study protocol; UA carried out the Fieldwork; MIA and UA carried out the analysis and interpretation of these data. MIA drafted the manuscript; UA critically revised the manuscript for intellectual content. The authors read and approved the final manuscript. The authors are guarantor of the paper.

Declarations

Funding: None

Conflicts of Interest

Author declares there is no conflict of interest.

Ethical Approval

Full ethical clearance was given by the Kaduna state government, Nigeria.

Ethical clearance was obtained from the Ethical and Scientific Committee of Kaduna State Ministry of Health, Kaduna. A signed or thumb-printed written consent was obtained from every respondent before data collection. The confidentiality of their identity and the information given is assured. Any participant who did not consent to participate in the study was excluded.

Acknowledgements

The authors of this study would like to acknowledge the cooperation received from the community where the study was carried out. This is really appreciated and has helped us to achieve the goals of this research.

Data Availability Statement

The data underlying this article will be shared on reasonable request to the corresponding author.

References

- [1] Akram, N. A., Shafiq, F. & Ashraf, M. (2018) 'peanut (*Arachis hypogaea* L.): a prospective legume crop to offer multiple health benefits under changing climate,' *Comprehensive Reviews in Food Science and Food Safety*, 17 (2018) pp1325-1338, available from: doi: 10.1111/1541-4337.12383 (accessed 13/10/2020).
- [2] Lusas, E. W. (1979) 'Food uses of peanut protein,' *Journal of the American Oil Chemists' Society*, 56 (3) pp 425-430. Available from: <https://doi.org/10.1007/BF02671530>.
- [3] Akhtar, S., Khalid, N., Ahmed, I., Shahzad, A. & Suleria, H. A. R. (2014) 'Physicochemical Characteristics, Functional Properties, and Nutritional Benefits of Peanut Oil: A Review,' *Critical Reviews in Food Science and Nutrition*, 54:12, 1562-1575, DOI: 10.1080/10408398.2011.644353.

- [4] Arya, S. S., Salve, A. R. & Chauhan, S. (2016) 'Peanuts as functional food: a review,' *Journal of Food Science and Technology*, 53 (1) pp 31 – 41. Available from: DOI: 10.1007/s13197-015-2007-9 (accessed 23/10/2020).
- [5] Katarzyna, S-Ł, Jaromin, A., Korycińska, M., Kozubek, A. (2011) 'Health Benefits of Peanut (*Arachis hypogaea* L.) Seeds and Peanut Oil Consumption,' in *Nuts and Seeds in Health and Disease Prevention* (ed). Academic Press. <https://doi.org/10.1016/B978-0-12-375688-6.10103-3>.
- [6] Guimón, J. & Guimón, P. (2012) 'How ready-to-use therapeutic food shapes a new technological regime to treat child malnutrition,' *Technological Forecasting and Social Change*, 79 (2012) pp 1319-1327. Available from: <https://dx.doi.org/10.1016/j.techfore.2012.04.011>.
- [7] Ali, E., Zachariah, R., Dahmane, A., Van den Boogaard, W., Shams, Z., Akter, T., Alders, P., Manzi, M., Allaouna, M., Draguez, B.,

- Delchevalerie, P. and Harries, A. D. (2013) 'Peanut-based ready-to-use therapeutic food: acceptability among malnourished children and community workers in Bangladesh,' *Public Health Action*, 3 (2) pp 128 – 135. Available from: <https://dx.doi.org/10.5588/pha.12.0077> (accessed: 23/09/2020).
- [8] AOAC International. 2003. Official methods of analysis of AOAC International. Association of Analytical Communities. 17th edition. Gaithersburg, MD, USA.
- [9] Atasié, V. N., Akinhanmi, T.F. and Ojiodu, C. C. (2009) 'proximate analysis and physico-chemical properties of groundnut (*Arachis hypogaea* L.),' *Journal of Nutrition*, 8 (2): 194-197. Available from: <https://scholar.google.com> (accessed 20/07/2021).
- [10] Zhao G, Liu Y, Zhao M, Ren J, Yang B. (2011) 'Enzymatic hydrolysis and their effects on conformational and functional properties of peanut protein isolate,' *Food Chem* 127(4):1438–1443. Available from: <https://scholar.google.com>.
- [11] Zhao, X., Chen, J. & Du, F. (2012) 'Potential use of peanut by-products in food processing: a review,' *Journal of Food Sci Technol* 49 pp 521-529. Available from: <https://doi.org/10.1007/s13197-011-1449-2>.
- [12] Vincent M. P., and Prakash, V. (1994) 'Functional properties of homogeneous protein fractions from peanut (*Arachis hypogaea* L.),' *Journal of Agricultural and Food Chemistry*, 42 (2) pp 274-278. Available from: <https://doi.org/10.1021/jf00038a009>.
- [14] Muhammad, N. B., Salihu, S., Umar, A. I. and Labbo, A. M. (2020) 'proximate composition and aflatoxin content in some varieties of locally produced groundnut (*Arachis hypogaea* L.) in Sokoto state, Nigeria,' *IJESC*, 10 (1) pp 24544-547. Available from: <https://ijesc.org>.
- [15] Musa, A. K., Kalejaiye, D. M., Ismaila, L. E. and Oyerinde, A. A. (2010) 'Proximate composition of selected groundnut varieties and their susceptibility to *Trogoderma granarium* Everts attack,' *Journal of Stored Products and Postharvest Research*, 1(2), pp. 13-17, Available from: <https://www.academicjournals.org/jsppr> (accessed 13/08/2021).
- [16] Wu HW, Wang Q, Ma TZ, Ren JJ (2009) 'Comparative studies on the functional properties of various proteins concentrates preparations of peanut protein,' *Food Res Int.* (42) pp 343–348, Available from: <https://scholar.google.com>.
- [17] Jiang R, Wang M, Davis S (2002) 'Nut and peanut butter consumption and risk of type 2 diabetes in women,' *Journal of American Medical Assoc.* 288 (20) pp 2554–2560, available from: <https://scholar.google.com>.
- [18] Jones, J. B., Provost, M., Keaver, L., Breen, C., Ludy, M-J., Mattes, R. D. (2014) 'A randomized trial on the effects of flavorings on the health benefits of daily peanut consumption,' *The American Journal of Clinical Nutrition*, 99 (3), pp 490 – 496. Available from: <https://doi.org/10.3945/ajcn.113.069401>.
- [19] Dibari, F., Bahwere, P., Le Gall, I., Guerrero, S., Mwaniki, D. & Seal, A. (2010) 'A qualitative investigation of adherence to nutritional therapy in malnourished adult AIDS patients in Kenya,' *Public Health Nutrition*, pp 1 – 8, Available from: DOI: 10.1017/S1368980010003435 (accessed, 12/11/2020).
- [20] Hurst, J., and M. Jee-Hughes (2001), 'Performance Measurement and Performance Management in OECD Health System', *OECD Labor Market and Social Policy Occasional Papers*, 47 (1) pp 2 – 68. Available from: <http://dx.doi.org/10.1787/788224073713>.
- [21] Yeşilada, F. & Direktör, E. (2010) 'Health care service quality: a comparison of public and private hospitals,' *African Journal of Business Management*, 4 (6) pp 962 – 971. Available from: <https://doi.org/10.5897/AJBM.9000314> (accessed: 21/11/2019).