Scholars Journal of Applied Medical Sciences
Abbreviated Key Title: Sch J App Med Sci
ISSN 2347-954X (Print) | ISSN 2320-6691 (Online)
Journal homepage: https://saspublishers.com

OPEN ACCESS

Public Health

Has Locally Consumed Grasshopper in Abuja, Nigeria, Any Therapeutic Value on Arthritis Disease, Public Health Wise?

Ajobiewe JO[1*], Ajobiewe HF[2], AjobieweCD[3], Yashim NA[1], Oguji C[4], Ogundeji AA[5], Sidi II[1], Omogah PO[1]

[1]National Hospital Abuja, Plot 132 Garki Central District, Nigeria
[2]Bingham University Karu Nasarawa State of Nigeria
[3]United State Department of Defence, Walter Reed Program –Nigeria US Embassy Nigeria
[4]Defence Reference Laboratory, Asokoro, Abuja, Nigeria
[5]University of Abuja Teaching Hospital

DOI: 10.36347/sjams.2021.v09i11.016 | **Received:** 01.08.2021 | **Accepted:** 04.09.2021 | **Published:** 24.11.2021

***Corresponding author:** Ajobiewe JO

Abstract **Original Research Article**

Arthritis is fast becoming chronic disease of rheological and compromised public health consequences, most especially on the quality of human corporate life and existence. The aim of this current study is simply to consider the level of awareness of the therapeutic effects, if any, of Grasshoppers on Arthritis. To some ethnic groups, insects provide 5–10% of protein, fat, calories, vitamins and minerals per year. This work's main objective is to critically appraise the level of awareness of the food value of Grasshoppers and its therapeutic potentials on arthritis patients. As useful information on these parameters could suggest the fountain and the basis of these claims and assertions. The method adopted in this current study randomly assigned and administered informed consent questionnaires to unisex participants attending some four hospitals' orthopedic departments within F.C.T. Abuja in Nigeria. Also they were fed with 25g of fifteen roasted grasshopper daily as afternoon snacks for eight months continuously without break. Using the unpaired t-test, we observed that the percentage curative rate in these unisex volunteers, though very high, showed no significant difference among the male and female participants aged 40 to 80 years ($P>0.05$). Majority of those interviewed within the community randomly selected actually seem to know about the importance and the usefulness of Grasshopper as far as therapeutic and food potentials are concerned.

Keywords: Grasshopper Therapeutic Value Arthritis Disease Public Health Wise.

1.0 INTRODUCTION

Insects are gaining more and more attention worldwide due to many ways of their exploitation [1, 2]. Many articles deal with insects in relation to developing countries, harvesting insects in nature and solving the problem of famine [3, 4], as in some cultures, insects present an important seasonal source of proteins and are a common part of the menu of a substantial part of human population, especially of Asian, African, Central American and South American cultures. In these areas, insect's consumption is associated, by no means always, with a poor-man's subsistence [5]. However, insects are not only an emergency resource but are appreciated as palatable and tasty [6, 7] and their popularity is also increasing in Westernized countries as a new, interesting food item [8]. Despite the fact that social, economic and nutritional values of edible insects are often marginalized, more than 1500 species of edible insects in 300 ethnic groups in 113 countries [9] have been recorded by various authors. To some ethnic groups insects provide 5–10% of protein, fat, calories, vitamins and minerals per year [9]. Harvesting insects as food, like any other food hunting and collecting activities, has the potential to become a threat to both the target species and the environment. Ramos-Elorduy [10] reported that the populations of some of the 30 edible insect species in the Mexican town of Tulancalo have declined because of over exploitation and this situation has led to a call for regulation of edible insects' exploitation in Mexico to ensure better management, production and conservation. Furthermore, potentially edible insects may contain higher than acceptable levels of chemicals due to frequent usage of pesticides, which also applies to some other parts of the world [11]. From this point of view it is obvious that especially in Europe it is not possible to collect insects for eating purposes in nature.

Previously, insects were eaten alive [12, 13]. Later they were served in some cultures also cooked, roasted or boiled (either insects *per se* or insect additives to food) or using other culinary techniques [14]. As the time went by, in some parts of the world insects were given the position of sophisticated gourmet dishes, offered in experimental restaurants, having totally changed the look and presenting them as much more attractive and savory [Nonaka, 2009 [15]. However, opinions differ on how the food from insect should look like. Eating insects whole or their body parts can be difficult for those brought up in Western societies. Some insect eaters on the contrary require visible insects in food, preferably whole bodies, which is an example of a unique Asian culture, whose people eat them for their delightful taste and also enjoy the process of collecting them [15]. On the other hand, people – especially in areas where insects were not consumed for a long time – prefer incorporating insects into the food in a way they are not visible – so they accept only the idea that the insects have a nutritional value. This shows that people especially in North America and Europe can eat insects if they do not know what they are eating, with the exception of individuals who have allergic reactions. These factors suggest that insect transformation will facilitate its consumption in the future. In practice, dried insects may be crushed or pulverized, and raw or boiled insects ground or mashed, making their insect form unrecognizable.

They simply become masses of protein and lipids. Grasshopper is both commonly eaten as a delicacy and an excellent source of protein and is consumed for medicinal purposes [16]. These insects are typically collected, dried in the sun, and then grounded into powder [16]. The powder can then be turned into a paste when mixed with water and ash and applied to the forehead to alleviate the pain of violent headaches [16].

2.0. LITERATURE REVIEW

Nutritional value – the chemical composition of edible insects

The insects could be considered a good nutritional food source especially of fat and protein [17, 18], they have been found to be a rich source of vitamins and minerals, especially iron and zinc [19].

Proteins

Insects are potentially an important energy efficient source of protein for humans; either through a direct consumption or as food supplements for stock (poultry, pigs and aquaculture) [20] and many nations have already been using it. For example, local communities in the Amazon region attain 8 to 70% of their dietary protein from insects and several other invertebrates such as spiders and earthworms [21]. However, there are large differences in protein sources. Developed nations have ahigher protein consumption *per capita* than developing nations – about 96 g/person/ day, but a much greater proportion – 65% of it is derived from meat. On the contrary, the protein consumption in developing countries is much lesser – about 56 g/person/day and a still lesser portion – only 25% of it is animal protein [14].

The high protein content is an indication that the insects can be of value in man and animal ration and can eventually replace higher animal protein usually absent in the diet of rural dwellers in developing countries [11]. The protein content varies by species of insects, but generally is of a good quality and high digestibility [22]. Analyses showed that in egg, larva, pupa and adult stages, the raw protein content is generally 15–81%/dry basis. The protein content of some insects is also higher than that of chicken eggs, meat and fowl [8]. The content of essential amino acids is 10–30% of all amino acids 35–50% [23]. The protein digestibility of insect protein reported values of 77–98% [22], especially after removing the exoskeleton [3].

This is only slightly lower than the values reported in other animal protein sources (egg 95%, beef 98% and casein 99%). Whole dried bees had the digestibility of 94.3% [24] and the moth *Clanis bilineata* 95.8% compared to casein [3]. Protein digestibility of fresh termites *Macrotermes subhylanus* was 90.49%, of the green form of grasshoppers *Ruspolia differens* 82.34% and of the brown form of grasshoppers *Ruspolia differens* 85.67% 24. The digestibility of insect protein is higher than that of many vegetable-based proteins [25].

Fats

Mostly, the fat content of edible insects is between 10–50%.Reports and analyzed results [26] have shown that many edible insects are rich in fat; witjuti grubs have nearly 40% of fat (a composition similar to olive oil) [27]. The fat content of insects depends on many factors such as species [17], reproductive stages, season, age (life stage), or sex [27], habitat and diet [17]. Female insects contain more fat than male insects [25]. The content of essential fatty acids is higher as compared with animal fats [23]. Similarly, the fatty acid composition of related species is different, as there are many factors playing a role, too. Largely it is influenced by the host plant on which they feed [25]. For insects that feed on a single food plant, the values are probably typical for all members of the species, in contrast, the fatty acid content of generalist feeders such as the house cricket, *A. domesticus*, is likely to vary widely depending on the diet being fed [25]. Lipids are vital in the structural and biological functioning of the cells and help in the transport of nutritionally essential fat-soluble vitamins [28]. Especially those of the omega-3 long chain polyunsaturated fatty acids have played an important role in human evolution, providing essential elements to build cerebral tissues [29]. Edible insects contain a good quality fatty acid especially long chain omega-3 fatty acids such as alpha-linoleic acid, eicosapentaenoic acid.

Carbohydrates

Carbohydrates in insects are formed mainly by chitin. The carbohydrate content of edible insects ranged from 6.71% in sting bug to 15.98% in cicada [17]. Chitin is a macromolecular compound that has a high nutritional and health value [31]. Chitin exists rarely in a pure form in nature but instead is usually in a complex matrix with other compounds (proteins, lipids and insignificant amounts of minerals).

Mineral elements

Analysis of mineral elements showed that edible insects are rich in nutritious elements such as potassium and sodium (*e.g.* cricket nymph), calcium (*e.g.* cricket adult), copper (*e.g. Usta terpsichore*, mealworm adult), iron (*e.g.* axayacatl – a mixture of several species of aquatic Hemiptera, giant mealworm), zinc (*e.g.* cricket nymph), manganese (*e.g.* cricket adult) and phosphorus *(e.g.* cricket adult) [32]. The mineral composition in general probably largely reflects the food sources of insects, both those which are present in the gastrointestinal tract and those which are incorporated into the insect's body as a reset of the food it consumed [25]. For example, the calcium content of wax worms, house crickets, mealworms and silkworms can all be increased 5 to 20-fold when fed a high calcium diet. This increase in calcium appeals to be solely due to the residual food in the gastrointestinal tract with little of the calcium being incorporated into the insect's body [25]. All insects contain high levels of phosphorus, which results in a calcium: phosphorus ratio of less than one. For most monogastric animals, phosphorus from animal sources is virtually 100% available, while plant-based phytate phosphorus is approximately 30% available. For insects prepared for human consumption, some of the elevated levels of iron and copper are likely the reset of metal that has leached from the cookware [25].

Vitamins

Studies dealing with the vitamin content in insects are insufficient, yet it is known that edible insects contain mainly carotene and vitamins B1, B2, B6, D, E, K and C [33-35]. As far as the A vitamin (retinol) is concerned, the data differ not only in dependence on the species, but also on the origin of analyzed insects, methods used and ways of preparation of the honey bee(*A. mellifera*) failed to detect any trace of retinol (vitamin A) or retinyl palmitate contrary to previous reports based on Carr-Price colorimetry. Bee brood is not a source of retinol for dietary or cosmetic purposes [36, 37]. Commercially raised insects appear to contain little or no beta-carotene, most wild-caught insects contain a variety of carotenoids (astaxanthin, alpha-carotene, beta--carotene, lutein, lycopene, teaxanthin and others), which they accumulate from their food. Most species of vertebrates can convert some of these carotenoids to retinol, so insects containing high levels of carotenoids may be a significant source of vitamin A for insectivorous vertebrates [25]. Insects appear to be a good source of most B-vitamins, but a number of insects appear to contain low levels of thiamin. These low levels are likely an effect of heat processing, although the low levels seen for house crickets and super worms are for raw, whole insects [25]. Utilization of insects as a protein source could benefit insect conservation through habitat protection [38]. Insects are essential agents feeding on organic matter in nature, and they efficiently exploit all organic sources. Studies dealing with the vitamin content in insects are insufficient, yet it is known that edible insects contain mainly carotene and vitamins B1, B2, B6, D, E, K and C [33]; Chen & Feng, 1999 [34, 35]. As far as the A vitamin (retinol) is concerned, the data differ not only in dependence on the species, but also on the origin of analyzed insects, methods used and ways of preparation.

Mineral elements

Analysis of mineral elements showed that edible insects are rich in nutritious elements such as potassium and sodium (*e.g.* cricket nymph), calcium (*e.g.* cricket adult), copper (*e.g. Usta terpsichore*, mealworm adult), iron (*e.g.* axayacatl– a mixture of several species of aquatic Hemiptera, giant mealworm), zinc (*e.g.* cricket nymph), manganese (*e.g.* cricket adult) and phosphorus *(e.g.* cricket adult) [32, 13, 25, 39]. The mineral composition in general probably largely reflects the food sources of insects, both those which are present in the gastrointestinal tract and those which are incorporated into the insect's body as a reset of the food it consumed [25]. For example, the calcium content of wax worms, house crickets, mealworms and silkworms can all be increased 5 to 20-fold when fed a high calcium diet. This increase in calcium appeals to be solely due to the residual food in the gastrointestinal tract with little of the calcium being incorporated into the insect's body [25]. All insects contain high levels of phosphorus, which results in a calcium: phosphorus ratio of less than one. For most monogastric animals, phosphorus from animal sources is virtually 100% available, while plant--based phytate phosphorus is approximately 30% available. For insects prepared for human consumption, some of the elevated levels of iron and copper are likely the reset of metal that has leached from the cookware [25].

WHY USE INSECTS AS FOOD FOR HUMANS

Unconscious consumption

People around the world eat insects unknowingly; as it is almost impossible to avoid contamination by insects or their parts in food [40] and many states had worked out lists with prescribed permissible levels of insect contamination in food [41]. Therefore, it is obvious that also the people who dislike insects have consumed insects or parts of them before, which contaminated food during food production or processing.

Traditions

For many nations and ethnic groups, especially in Asia, Africa, South America and Australia insects are an indispensable and really traditional food. However, the availability of freely living edible insects is unpredictable, both in time and in location. Therefore, such ethnic groups must leverage current food supplies, as they lack the more sophisticated methods of preservation than drying in the sun or smoking over a fire. This readily available source of food is also used because of the sheer necessity [37].

Famine

Human population is growing exponentially and according to the opinion of specialists, we are very close to the global food crisis and famine [3, 13]. As people in rural areas suffer from under nutrition, especially protein-energy malnutrition (PEM), alternative-nutritional food source is needed – among other sources also insects with high-fat content [17]. Current field crop management practices and the potential of animals, used as a source of animal protein, are reaching their limits. The world is calling for a review of food and its resources obtaining methods [13].

Good taste

The taste of insects depends on many factors – primarily the species of insects, stage of live-cycle and food received [10, 42]. Given the large number of known species of edible insects and experience of native inhabitants, there is no problem all over the world to choose those, which conform to the current taste of eater. The dishes with a harmonious taste may represent true gourmet delicacies [8].

Nutritional aspects

Large numbers of known edible insect species at the same time also offer a choice of species regarding the nutritional requirements of consumers not only to replenish essential nutrients, but also microelements. Insects provide sugar (honey ants, sugar bags, and lerps) and fat (grubs, Bogong moths) [43]. Ants containing much iron can substitute chemical sources of this element [22]. Insects can be an alternative for vegetarians, because to some of them insects, unlike livestock meat, can be acceptable and addition of animal foods greatly increases the amino acid score of food [44].

Modern drugs discovery process involves the search of biologically active compounds derived from different sources. According to the knowledge on drugs of natural origin, active compounds were discovered in plants, insects and natural products and have been used in medicine since ages. The current trend in research is to identify biologically active compounds in insects. In the last decade an impreddive number of active compounds were isolated from insects, especially peptides with miotropic and antifungal properties. Grasshoppers are also used medicinally [44]. They are said to serve as diuretic to treat kidney diseases, to reduce swelling, and to relieve the pain of intestinal disorders when they are consumed [44].

Metabolomics is a relatively new discipline of bioscience aiming at understanding of the metabolic state of a biological system. Results of qualitative and quantitative determinations of metabolites in the organism can be related to differences in biological reactions to various stimuli. Genetic and environmental factors can affect metabolites concentration, which in turn, can determine several physiological responses [43].

Metabolomics, as a part of functional genomics, plays an important role in medically oriented research on insects and plants [44]. Fingerprint analysis, performed by complementary gas and liquid chromatography, coupled with the mass spectrometry technique, is a fundamental approach in metabolomics studies. One of mass spectrometry's beneficial features is its usefulness in identification of metabolites in complex biological material. Such identified metabolites might next be recognized as specific biomarkers or so-called "lead" structures for rational drug design for determining a wide range of chemical structures, such as amino acids, carbohydrates, sugars, fatty acids and lipids, in complex matrices. This platform is dedicated to determine volatile compounds as well as those, which could easily be derivatized [44]. Moreover, it is the best one to perform analysis of polar compounds, like amino acids. The advantages of GC/MS are: its high sensitivity, reproducibility and possibility to determine large amounts of compounds (200–300) in a single analysis. A performed advantage of GC/MS is a possibility of compounds' identification Substances with biological activity have been sought since ages but still searching for new bioactive agents is necessary. Nowadays, much attention is dedicated to insect's metabolites, because of their unique, myotropic and cardiotropic properties [44]. The usage of bioactive compounds obtained from herbs, insects or animals has been highlighted in folk medicine [43]. According to the ethnographic literature [44] and childhood's memories of one of the authors (Roman Kaliszan), villagers of West-Central and South Poland used the grasshopper abdominal secretion for wound healing and in wart treatment. Interestingly, the grasshopper abdominal secretion is characterized by extraordinary rheological properties.

The most common Polish species of grasshopper genus are *Chorthippus biguttulus*, *Chorthippus montanus* and *Chorthippus parallelus*. The common territories of occurrence of the three species are sunny meadows and fields.

On the basis of folk premises, an ointment-like material, squeezed out from grasshopper ovipositor, facilitates healing of wounds and scars. Ovipositor is an egg-laying structure at the end of the abdomen in many female insects. One of the most important life processes of female grasshoppers is reproduction and laying eggs into the solid surface, which are highly dependent on insect's hormone secretion [4, 6-8]. The eggs are suspended in abdominal secretion produced by gonads [41]. A characteristic feature of secretion is its protective role. It should protect the insects' eggs against pathogens, dehydration, and fill the space between eggs [44]. It is known also as a thermo-isolating and nourishing material for eggs [44].

STATEMENT OF PROBLEM

Over the years, arthritis has been a disease that affects humans. Lasting solution through the use of orthodox drugs has proved abortive. There is need to look inwards by harvesting what the nature has for us which culminates into carrying out a research to identify the curative agent in grasshopper that has therapeutic effect on the disease.

MATERIALS AND METHODS

This research was aimed at providing new local compounds of natural origin which could be used as medicine or evaluated for subsequent drug design. As such some arthritis volunteers, whose ages ranged between 40-80 years, were fed with 25g of fifteen roasted grasshopper daily as afternoon snacks for eight months continuously without break. Also, informed research questionnaires were randomly distributed to other patient attendee in the orthopedic departments of the chosen hospitals for the first part of this research in order to test their general levels of awareness of the importance of Grasshopper in health, the unpaired t-test was adopted in analyzing results. While the other part (not in this current paper) dealt quantitatively on metabolomics using sound experimental principles. Here, in the preparation of samples Fresh grasshoppers were oven dried, grinded and hydrolyzed for analysis. Determinations was performed for water content, crude fiber (structural Carbohydrates), fat, free nitrogen extract, mineral salts and vitamin B using the method reported by the Association of Official and Analytical Chemists (A.O.A.C., 1975). The crude proteins would be determined using kjeldahl technique. The bacterial and parasitic load of the grasshoppers was determined. The hydrolyzed solution shall be injected into the articular joint of the rabbits.

Experimental design

Randomized block design was used. The experimental design in which each block contains a replication of the treatments, which are allocated to the various units within the blocks in a random manner to avoid bias. The prospective study comprised of three sets of rabbits. Each set consists of 4 rabbits placed in a cage. In a block, there were 5 (five) treatments. Also in the second part of this work, details of induction of inflammation in rabbit articular joints were extensively discussed.

HYPOTHESIS

Ho: There is no significant difference in the effective therapeutic value of grasshopper between adult Male and Female hospital attendee at the orthopaedic departments of the four hospitals within FCT Abuja.

Ha: Significant difference exists in the effective therapeutic value of grasshopper between adult Male and Female hospital attendee at the orthopaedic departments of the four hospitals within FCT Abuja.

Some of the answers of the key research questions randomly administered to the patients at the various orthopaedic departments are as shown in the result table:

RESULTS

Table-1: Showing Curative Rates of Grasshoppers on Unisex Volunteers Arthritis Patients Attending Four Hospitals in Abuja

	CURE RATES		**MALES**		**FEMALES**	
AGE (YEARS)	**40- 80**		**(X-X)**	**$(X-X)^2$**	**(X-X)**	**$(X-X)^2$**
HOSPITALS	**MALE**	**FEMALE**				
A	48/50 (96%)	23/25 (92%)	96-93.8	4.84	92-95	9
B	67/70 (95%)	20/20 (100%)	95-93.8	1.44	100-95	25
C	10/11 (88%)	15/17 (88%)	90-93.8	14.44	88-95	49
D	18/19 (94%)	13/13 (100%)	94-93.8	0.04	100-95	25
MEAN	**93.75%**	**95%**	$\sum(X-X)^2$	**20.4**	$\sum(X-X)^2$	**108**
		SD		**2.25**		**5.2**

STANDARD DEVIATION, SD, = $\sqrt{\sum(X-X)^2 / n-1}$

T test = X1 – X2 / SE = 0.33

T tabulated = 2.1

T Calculated at six degrees of freedom = 0.33 (Not significant)

Hence, we have no reason to reject the null hypothesis thus it is retained.

Table-2: Level of Awareness of the Therapeutic/Food value of Grasshopper among Females

	HOSPITALS	A	B	C	D
Male participants with insects Metabolomics knowledge		2/25 (8%)	2/20 (10%)	2/17 (11.7%)	1/13 (0.077%)
Insects (Grasshoppers) have a lot of protein ,fat, vitamins food value		23/25 (92%)	18/20 (90%)	15/17 (88.23%)	12/13 (92.30%)
Grasshoppers are consumed for medicinal reasons	Strongly agree	3/25 (12.0%)	16/20 (80.0%)	9/17 (52.94%)	0/13 (0.0%)
	Strongly disagree	21/25(84.0%)	4/20 (20.0%)	8/17 (47.05%)	1/13(7.69%)
	Not aware	1/25 (4.0%)	0/20 (0.0%)	0/17 (0.0%)	12/13 (92.30%)
Grasshoppers /Other Insects Serve as food supplement during Famine	Strongly agree Strongly disagree	8/25 (32.0%) 17/25 (68.0%)	10/20(50%) 10/20(50%)	14/17 (82.35%) 3/17(17.65%	11/13 (84.62%) 2/13 (15.38%)

Table-3: Level of Awareness of the Therapeutic/Food value of Grasshopper among Males

	HOSPITALS	A	B	C	D
Female participants with insects Metabolomics knowledge		6/50 (12%)	1/70 (1.40%)	2/11 (18.1%)	1/19 (5.3%)
Insects (Grasshopper) has a lot of protein ,fat, vitamins food value		44/50 (88%)	62/70 (88.6%)	7/11 63.6%	16/19 (84%)
Grasshoppers are consumed for medicinal reasons	Strongly agree	30/50 (60%)	40/70 (57.14%)	2/11 (18.18%)	5/19 (26.3%)
	Strongly disagree	15/50 (30%)	15/70 (21.14%)	8/11 (72.72%)	7/19(36.8)
	Not aware	5/50 (10%)	15/70 (21.14%)	1/11 (9.09%)	7/19 (36.8%)
Grass Hoppers /Other Insects Serve as food supplement during Famine	Strongly agree Strongly disagree	25/50 (50%) 25/50 (50%)	40/70 (57.14%) 30/70(57.14%)	3/11 (27.27%) 8/11(72.72%	16/19 (84%) 3/19 (16%)

Table-4: A chart which shows the average cure rate of grasshoppers on unisex volunteer's arthritis patient in four hospitals in Abuja

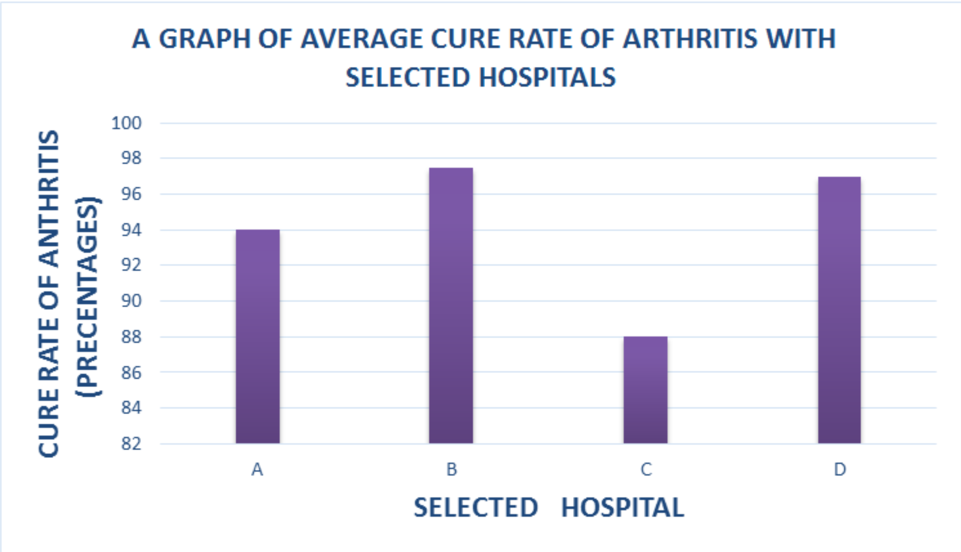


Table-5: Chart showing the level of awareness of therapeutic/food value of grasshoppers among females among selected hospitals

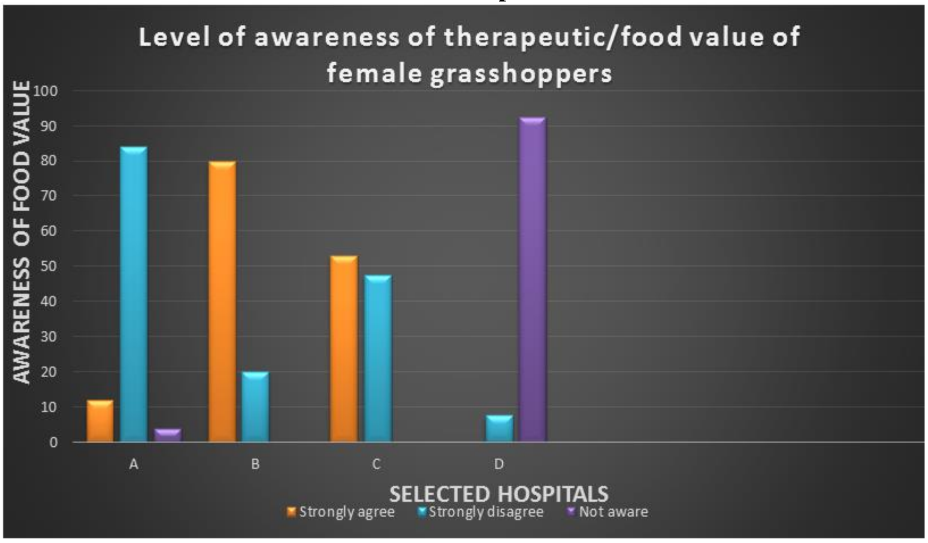
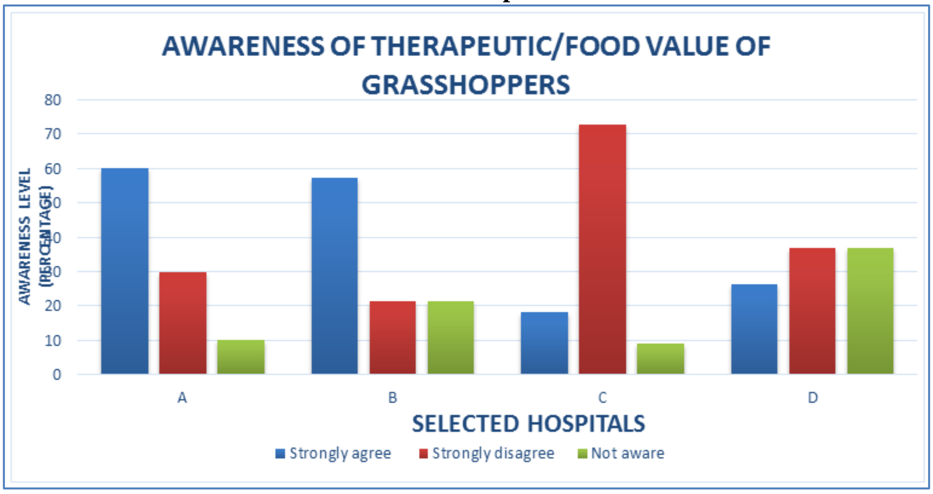


Table-6: A chart showing the level of awareness of therapeutic/food value of grasshoppers among males in selected hospitals



DISCUSSION

Table A; which showed the curative rates of the Grasshoppers consumed by the male volunteers in the four hospitals viz;- Hospital A 48/50 (96%), Hospital B 67/70 (95%), Hospital C 10/11 (88%), and Hospital D 18/19 (94%), While for the females volunteers the curative rates of the Grasshoppers consumed in the four hospitals viz;- Hospital A 23/25 (92%), Hospital B 20/20 (100%), Hospital C 15/17(88%), and Hospital D 13/13 (100%), With these figures, It is suggested that grasshopper consumption could be the right therapeutic remedy for patients suffering from arthritis. As the positive cure response rate ranged from 88% to 100% unisex. According to Koek *et al.* [47], Metabolomics, as a part of functional genomics, plays an important role in medically oriented research on insects and plants Koek *et al.* [47]. Such identified metabolites might next be recognized as specific biomarkers or so-called "lead" structures for rational drug design for determining a wide range of chemical structures, such as amino acids, carbohydrates, sugars, fatty acids and lipids, in complex matrices. The grasshopper could in future be used to determine volatile compounds as well as those, which could easily be derivatized as rightly pointed out by Desbrosses *et al.* [48]. Unfortunately, only relatively few volunteers were aware of this fact. For the sake of future research, the grasshopper importance in providing lasting relieve and cure for arthritis must be emphasized, deeply researched and its useful metabolites identified for orthodox medicine design. In table 2, apart from the relatively low level of the metabolomics awareness level, most of them i.e. the volunteers knew about the relatively high food value of insects as typified by grasshopper as they all responded well and acknowledged that grasshopper contain high levels of amino acids, carbohydrates, sugars, fatty acids and lipids. For this reason they believe it could be used as food alternatives. Just as observed by Desbrosses *et al.*

CONCLUSION

The grasshopper could be a real source for future drug design against arthritis which is a disease that is currently difficult to treat. In the second part of the work we intend to conduct a deeper scientific research, where full analysis of the food components proportions either in the exoskeleton or other parts of the insect/Grasshopper shall be determined quantitatively.

REFERENCES

1. Cerritos, R. (2011). Grasshoppers in agrosystems: Pest or food? CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources, 6, 1–9.
2. Chen, X., Feng, Y., Chen, Z. (2009). Common edible insects and their utilization in China. *J. Entomol. Res*, 39, 299–303.
3. De Foliart, G.R. (1992). Insects as human food. *Crop Prot*., 11, 395–399.
4. Katayama, N., Ishikawa, Y., Takaoki, M., Yamashita, M., Nakayama, S., Kiguchi, K., & Force, S. A. T. (2008). Entomophagy: A key to space agriculture. *Advances in Space Research*, *41*(5), 701-705.
5. Paoletti, M. G. (2005). *Ecological Implications of Minilivestock: Potential of Insects, Rodents, Frogs and Sails*. CRC Press.
6. Nonaka, K. (2009). Feasting on insects. *J. Entomol. Res.*, 39, 304–312.
7. Akinnawo, O., & Ketiku, A. O. (2000). Chemical composition and fatty acid profile of edible larva of Cirina forda (Westwood). *African Journal of Biomedical Research*, *3*(2), 93-96.
8. Comby, B., & Messager, L. (1990). *Délicieux insectes: les protéines du futur*... Ed. Jouvence.
9. Banjo, A. D., Lawal, O. A., & Songonuga, E. A. (2006). The nutritional value of fourteen species of edible insects in southwestern Nigeria. *African journal of Biotechnology*, *5*(3), 298-301.
10. Ramos-Elorduy, J. (1996). Insect consumption as a mean of national identity. *SJ Jain, Ethnobiology in Human Welfare, Deep Publication, New Delhi*, 9-12.
11. Chen, X., & Feng, Y. (1999). The edible insects of China. *Beijing, China: Science and Technology Publishing House*.
12. Ozimek, L., Sauer, W. C., Kozikowski, V., Ryan, J. K., JØRgensen, H., & Jelen, P. (1985). Nutritive value of protein extracted from honey bees. *Journal of Food Science*, *50*(5), 1327-1329.
13. Kinyuru, J. N., Kenji, G. M., Njoroge, S. M., & Ayieko, M. (2010). Effect of processing methods on the in vitro protein digestibility and vitamin content of edible winged termite (Macrotermes subhylanus) and grasshopper (Ruspolia differens). *Food and bioprocess technology*, *3*(5), 778-782.
14. Finke, M.D. (2004). Encyclopedia of Entomology, 1st ed., Kluwer Academic Press: Dordrecht, the Netherlands.
15. Naughton, J. M., O'Dea, K., & Sinclair, A. J. (1986). Animal foods in traditional Australian aboriginal diets: polyunsaturated and low in fat. *Lipids*, *21*(11), 684-690.
16. Pennino, M., Dierenfeld, E. S., & Behler, J. L. (1991). Retinol, α-tocopherol and proximate nutrient composition of invertebrates used as feed. *International Zoo Yearbook*, *30*(1), 143-149.
17. Omotoso, O. T. (2006). Nutritional quality, functional properties and anti-nutrient compositions of the larva of Cirina forda (Westwood)(Lepidoptera: Saturniidae). *Journal of Zhejiang University Science B*, *7*(1), 51-55.
18. Crawford, M., Galli, C., Visioli, F., Renaud, S., Simopoulos, A. P., & Spector, A. A. (2000). Role of plant-derived omega–3 fatty acids in human nutrition. *Annals of Nutrition and Metabolism*, *44*(5-6), 263-265.
19. Burton, O. T., & Zaccone, P. (2007). The potential role of chitin in allergic reactions. *Trends in immunology*, *28*(10), 419-422.
20. Oliveira, J. S., de Carvalho, J. P., De Sousa, R. B., & Simao, M. M. (1976). The nutritional value of four species of insects consumed in Angola. *Ecology of Food and Nutrition*, *5*(2), 91-97.
21. Lu, Y., Wang, D.R., Han, D.B., Zhang, Z.S., Zhang, C.H. (1992). Analysis of the patterns and contents of amino acids and fatty acids from *M. annandalei* (Silvestre) and *M. barneyi* Light. *Acta Nutr. Sin*., 14, 103–106.
22. Ying, F., Xiao-ming, C. H. E. N., Shou-de, Y. E., Shao-yun, W. A. N. G., Yong, C. H. E. N., & Zi-li, W. A. N. G. (2012). Records of four species edible insects in Homoptera and their nutritious elements analysis. *林业科学研究*, *12*(5), 515-518.
23. Barker, D., Fitzpatrick, M. P., & Dierenfeld, E. S. (1998). Nutrient composition of selected whole invertebrates. *Zoo Biology: Published in affiliation with the American Zoo and Aquarium Association*, *17*(2), 123-134.
24. Ramos-Elorduy, J., Moreno, J. M. P., Prado, E. E., Perez, M. A., Otero, J. L., & De Guevara, O. L. (1997). Nutritional value of edible insects from the state of Oaxaca, Mexico. *Journal of food composition and analysis*, *10*(2), 142-157.
25. Mitsuhashi, J. (2010). The future use of insects as human food. *Forest insects as food: humans bite back*, *115*, 122.
26. FDA. (2012). Levels of natural or unavoidable defects in Foods that present no health hazards for humans, first ed. Silver Spring, Maryland.
27. Marconi, S., Manzi, P., Pizzoferrato, L., Buscardo, E., Cerda, H., Hernandez, D. L., & Paoletti, M. G. (2002). Nutritional Evaluation of Terrestrial Invertebrates as Traditional Food in Amazonia1. *Biotropica*, *34*(2), 273-280.

28. Katayama, N., Yamashita, M., Wada, H., & Mitsuhashi, J. (2005). Entomophagy as part of a space diet for habitation on Mars. *The Journal of Space Technology and Science*, *21*(2), 2_27-2_38.
29. Woo, H.M., Kim, K.M., Choi, M.H., Jung, B.H., Lee, J., Kong, G., Nam, S.J., Kim, S., Bai, S.W. (2009). Chung BCh. *Clin Chem Acta,* 400:63-69.doi: 10.1016/j.cca.2008.10.014.
30. Katajamaa, M., *Oresic, M.* (2007). *J Chromatogr* A, 1158:318-328.doi: 10.1016/j.chroma.2007.04.021.
31. Koek, M.M., Jellema, R.H. (2011). Van der Greef, Tas AS, Hankemeier T. *Metabolomics*. 2011:7:307-328. Doi: 10.1007/s11306-010-0254-3.
32. Desbrosses, G., Steinhauser, D., Kopta, J., Udvardi, M Inc. (2005). Metabvolome analysis using GCMS. Marque AJ, editor. Dordrecht: Springer.
33. Marcinaik, P., Szymczak, M., Rosinski, G. (2011). Postepy biologii komorki, 38; 43-63. Sztych D. Zycie Weterynaryjine, 88; 126-131.
34. Tsugawa, H., Tsujimoto, Y., Arita, M., Bamba, T., Fukusaki, E. (2011). *Bioinformatics*, 12:131-143.
35. Sanchez, D., Ganformia, M.D., Bastiani, M.J. (2000). BBA; 1482; 102-109.
36. Srivastava, S.K., Babu, N., & Pandey, H. (2009). Traditional insect bio prospecting-As human food and medicine. *Indian Journal of Traditional Medicine*, *8*(4); 485-494.
37. Ramos-Elorduy de Conconi. J., & J.M. Pino Moreno. (1988). The utilization of insects in the empirical medicine of ancient Mexicans. *Journal of Ethnobiology, 8(*2),195-202.
38. Dunn, W., Broad, Hurst, D., Berley, P., Zelena, E., Francis-Mclntyre, S., Anderson, N., Brown, M., Knowles, J.D., Halsall, A., Haselden, J.N., Nicholls, A.W., Wilson, I.D., Kell, D.B. (2011). *Nat Protoc*. 6:1060-1083. Doi: 10.1038/nprot.2011.335.
39. Willoughby, D. A. (1975). Human arthritis applied to animal models-towards a better therapy. Annals of the Rheumatic Diseases, 34, 471-478. Copyright. On 21 August 2018 by guest. Protected by *http://ard.bmj.com/ Ann Rheum Dis*: first published as 10.1136/ard.38.1.89 on 1 February 1979. Dow
40. Imrie, R. C. (1976). Animal models of arthritis. Laboratory Animal Science, 26, 345-351.
41. Davis, B. (1971). Effects of prednisolone in an experimental model of arthritis in the rabbit. *Annals of the Rheumatic Diseases*, 30, 509-52.
42. Deshmukh, K., & Hemrick, S. (1976). Metabolic changes in rabbit articular cartilage due to inflammation. *Arthritis and Rheumatism*, 19, 199-208.
43. Goldlust, M. B., Rich, L. C., & Harrity, T. W. (1977). Effects of anti-inflammatory agents on the acute response of immune synovitis in rabbits. Arthritis and Rheumatism, 20, 937-946.
44. Page-Thomas, D. P. (1977). Aspects of synovial biodegradation. Bayer Symposium VI. Experimental Models of Chronic Inflammatory Diseases, 353-365.
45. Edited by L. E. Glynn., & H. D. Schlumberger. (1975). Springer-Verlay: Berlin. Ring, E. F. J. *Thermography and rheumatic diseases*.