NNPublication Journal of Advance Research in Medical and Health Science ISSN: 2208-2425

DOI: https://doi.org/10.61841/e1sv7p88 Publication URL: https://nnpub.org/index.php/MHS/article/view/2208

DETERMINATION OF SPECIFIC HEAT CAPACITIES OF LIQUIDS FROM SOME CONSUMABLE ITEMS

Joseph Gordian Atat, *Emmanuel Bassey Umoren, Sunday Samuel Ekpo and Unyime Akpan Umoette

Department of Physics, University of Uyo, Uyo, Nigeria.

Corresponding Author:
emmanuelumoren@uniuyo.edu.ng

ABSTRACT

This study was done to obtain the Specific Heat Capacities (SHC) of some liquids from some intake items (they are consumed widely in Niger Delta, Nigeria). These items are vegetables (Afang leaf, Pumpkin leaf, Bitter leaf, Scent leaf, Water leaf), fruits (Orange, Cucumber, Pineapple, Watermelon, Lime) and juice (Ribena, Chivita Exotic, Chivita Happy Hour, Chivita Active and Five Alive). Calorimeter was used and Method of mixtures was adopted for this finding. Measured parameters were obtained in the laboratory. Microsoft Excel was used for other analyses and computation of results. The vegetable results show that the average SHC of the liquid content from Afang is 1679.999JKg^{-1}k^{-1}, Pumpkin is 3752.608 JKg^{-1}k^{-1}, Bitter leaf is 3619.235JKg^{-1}k^{-1}, Waterleaf is 8790.352JKg^{-1}k^{-1}, Scent leaf equals 7121.063JKg^{-1}k^{-1}; those from the liquid content of fruits are Orange (5993.524JKg^{-1}k^{-1}), Cucumber (4163.477 JKg^{-1}k^{-1}), Pineapple (5113.043JKg^{-1}k^{-1}), Watermelon (6026.086JKg^{-1}k^{-1}), White portion of Watermelon (6347.037JKg^{-1}k^{-1}), Red portion of Watermelon (3657.807JKg^{-1}k^{-1}), Lime (6026.086J/Kg^{-1}K^{-1}) and the ones obtained from juice such as Ribena is 3101.568 JKg^{-1}k^{-1}, Five Alive as 5113.043 JKg^{-1}k^{-1}, Chivita Exotic as 6798.359JKg^{-1}k^{-1}, Chivita Active equals 6003.746 JKg^{-1}k^{-1}, Chivita Happy Hour = 3650.246JKg^{-1}k^{-1}. This outcome will help maintain the body temperature if those with heat challenges consider this recommendation. These items also contain vitamins and minerals for body building. Water leaf with the highest SHC value is strongly recommended as part of our daily delicacy. Other liquids whose SHC is about 4200JKg^{-1}K^{-1} are good. Afang in particular should be avoided by those with internal heat problems.

Keywords: *Specific heat capacity, vegetable, fruit, juice, method of mixtures, liquids.*

INTRODUCTION

Specific heat capacity is an important thermo-physical property that measures the ability of energy storage of the substance, defined as the amount of heat required to increase the temperature by 1k of a substrate per unit mass. Due to the high specific heat capacity, water is widely used as a medium in the heat transfer and cooling process of devices (Steeneveld *et al.,* 2014). The Specific heat capacity may be determined using different methods. Some of these methods include: Method of mixtures, Electrical method, Continuous flow method and Mechanical method. Specific Heat Capacity of a substance may also be seen as the heat capacity of a sample of the substance divided by the mass of the sample. The S.I unit of specific heat capacity is Joule per kilogram per kelvin ($JKg^{-1}k^{-1}$).

Some researchers have conducted researches to determine the specific heat capacity of different substances. Sun *et al.* (2020) had worked on the specific heat capacity in order to examine the thermophysical properties of nanoconfined water. Tombari *et al.* (2005) investigated the specific heat capacity of water confined in glass nanopores in a mean diameter of 4nm using calorimetry. Nagoe *et al.* (2015) has determined the specific heat capacity of benzene confined in MCM-41 mesopores. Inelastic neutron scattering technique has also developed to estimate the specific heat capacity of liquid confined in nanopores (Gautam *et al.,* 2018). Feidt (2017) carried out research on specific heat capacity as the amount of heat to be supplied to or taken out of the unit mass of a system in order to increase or decrease its temperature by one degree in a thermodynamic process. Zalba *et al.* (2003) investigated the specific heat capacities of various materials used in thermal energy storage applications. The researcher measured the specific heat capacities of several substances, including phase change materials and metal alloys and assessed their suitability for thermal energy storage.

Vegetables are important part of healthy intake and provide a source of many nutrients. Vegetables are an important part of healthy eating which is grown in soil. As noted by Atat and Umoren (2016), this soil is a soft spot in the terrain that can be used for planting seeds. Soils condition could be bed rock, stiff or soft soil (Atat and Umoren, 2016). Soft soil which is loose soil easily allows roots penetrate and promote their growth. It provides a source of many nutrients. According to Ekpo et al. (2021), these vegetables are used in preparing many delicacies. They provide an abundant and inexpensive source of energy, body building nutrients, vitamins and minerals. They are an important part of the world agricultural food production, even though their production volumes are small compared with grains (Ekpunobi *et al*., 2014). Their consumption provides taste, palatability, increases appetite and provides fibre for digestion among other things. Fruits are needed to boast important vitamins and minerals in the human body. It describes any fleshy part of a plant that has developed from a flower and has seeds. Fruits and vegetables often contain a number of essential vitamins and minerals that cannot be found in other classes of food or they may contain higher levels of these nutrients than other foods. Fruits and vegetables are an important part of the diet. Some of the benefits of consuming them include: lower risk of cancer, healthy memory function, healthy urinary tract, healthy aging and healthy heart (Rethaiaa *et al*., 2010). Regular consumption of fruit is associated with reduced risks of cancer, cardiovascular disease, stroke, Alzheimer disease, cataracts and among others (Liu, 2003). Moreso, fruits and vegetables provide water, fiber and lots of nutrients for many different functions in the body (Khalid, 2011; Roque, 2006). Also include aiding strong immune system, healthy heart and vision. inclusion of fruit and vegetable in junk food would convert the food into healthy food (Khalid, 2011). There are a number of recent studies suggesting that the current recommendations are associated with lower risk of certain diseases, such as high blood pressure, heart disease and cancer (Yahia *et al.,* 2008). A diet rich in vegetables and fruits can lower blood pressure, reduce the risk of heart disease and stroke, prevent some types of cancer, lower risk of eye and digestive problems, and have a positive effect upon blood sugar, which can help keep appetite in check.

The purpose of this research is to assess how much heat is needed to raise the temperature of some human consumable liquid items. It is a property that helps us understand how different substances absorb and release heat. In the case of vegetables, fruit and selected juice, determining their specific heat capacity is important. Minerals and vitamins are very necessary in maintaining body temperature and some persons (patients) are advised to take only water due to internal heat challenges, so consumable items whose specific heat capacity is greater than that of water may be recommended for such group of patients. Vegetables, fruits and juices are highly needed and consumed by man in order to support healthy growth and development. Water has a high specific heat capacity due to the strength of the hydrogen bonds; it absorbs a lot of heat before it begins to get hot. If some fluids that are not harmful to the body have the ability to absorb heat before it begins to get hot as they have other edible nutrient than water, then they could be recommended to persons with internally generated heat challenges.

THEORETICAL BASIS

Specific heat capacity is the quantity of heat (J) absorbed per unit mass (kg) of the material when its temperature increases 1 K (or 1 °C), and its unit is $Jkg^{-1}K^{-1}$. It is also, the energy required to raise 1kg (or a unit mass) of the material by 1℃ (Smith and Johnson, 2018). Mercan *et al.,* (2022) defined specific heat capacity defined as the heat which can increase one unit temperature of a mass unit temperature of a mass unit of a substance. Determination of heat capacity is critical because it is an important parameter for the prediction of heat transfer capacity. It is usually represented with the symbol, c. The specific heat capacity may be expressed mathematically as stated in Equation 1.

$\Delta Q = mc\Delta T$ (1)
Where ΔQ is the heat added or lost, m is the mass of the substance whose specific heat capacity is to be determined, c is the specific heat capacity and ΔT is the change in temperature. Equation 2 presents the relationship between heat lost and heat gained from which Equation is obtained.

$$m_S C_S \Delta T_S = m_C C_C \Delta T_C + m_W C_W \Delta T_W \quad (2)$$
$$C_S = \frac{m_C C_C \Delta T_C + m_W C_W \Delta W}{m_S \Delta T_S} \quad (3)$$

Here, C_S can be determined if C_W and C_C are known
$C_W = 4200 Jkg^{-1}k^{-1}$
$C_C = 420 Jkg^{-1}k^{-1}$

Equation 5 is an expression suitable for the determination of the specific heat capacity of a liquid by method of mixtures.
$H_L = H_G$
$$m_S C_S \Delta T_S = m_L C_L \Delta T_L + m_C C_C \Delta T_C \quad (4)$$
$$C_L = \frac{m_S C_S \Delta T_S - m_C C_C \Delta T_C}{m_L \Delta T_L} \quad (5)$$

Where: m_S = mass of a solid
C_S = Specific heat of solid
ΔT_S = Change in temperature in solid
m_C = Mass of a calorimeter
C_C = Specific heat of calorimeter
ΔT_C = Change in temperature of calorimeter
m_W = Mass of water
C_W = Specific heat of water
ΔT_W = Change in temperature of water
H_L = Heat loss
H_G = Heat gain

Location and Geology of the Study Area

Niger Delta (Figure 1) is located within latitudes $3°N$ and $6°N$; longitudes $5°E$ and $8°E$. Atat et al. (2020a), Atat *et al.* (2022), Reijers *et al*. (1996), Klett *et al*. (1997), Akpabio et al. (2023) and Umoren et al. (2019) are in agreement that this information is accurate. Both wet and dry seasons are noted in each year as other regions of the country (Atat et al., 2020a; Atat and Umoren, 2016) and the average rain in a month during wet season is about 1.35×10^2mm and reduces to 6.50 $\times 10^1$mm while approaching dry season (Atat *et al*., 2020b; George *et al*., 2010; Atat *et al.,* 2012). Groundwater is tapped from the top of stratigraphic sequence (George *et al*., 2017). The volume of sediment is nearly 500000km^3 (Atat *et al.*, 2020c, 2020e; Umoren *et al*., 2020; Hospers, 1965). The people major intake items include: vegetables, fruits, juice and cassava. Oil is classified in this basin as Akata-Agbada (Atat et al., 2020d). The Agbada formation is the main oil reservoir in the Niger Delta (Atat et al., 2020d). The sediment accumulated may define the energy of depositing medium as turbulent or calm (Oladipo et al., 2018). According to Oladipo et al. (2018), the sediment could also be used to investigate the mineralogical maturity of mineral presence in the region. The people major intake items include: vegetables, fruits, juice and cassava.

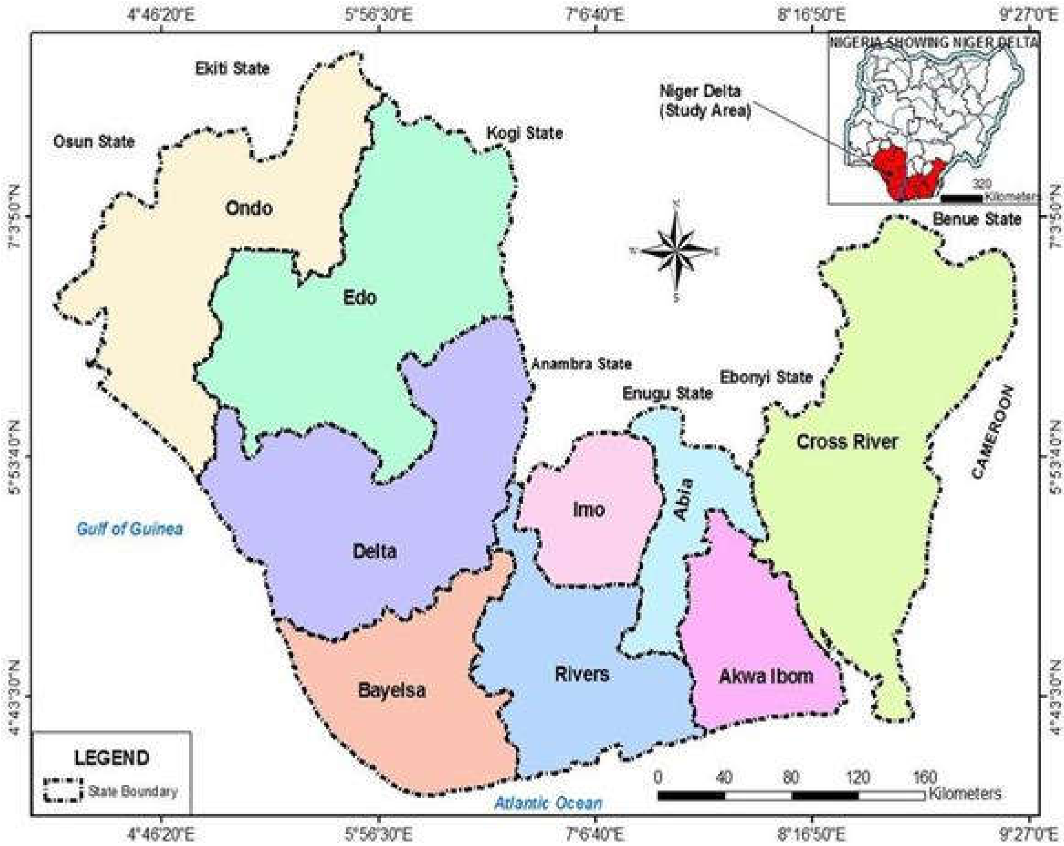

Figure 1: Map of Niger Delta

MATERIALS AND METHOD

Materials

In order to measure the specific heat capacity of vegetables, fruits and fruit juices, the items or materials used are highlighted in Figures 2 to 4. Apparatus used were those which is adequate for method of mixtures.

Figure 2: Vegetable items used (a for pumpkin leaf: *Cucurbita maxima*; b for waterleaf: *Talinum triangulare*; c for bitter leaf: *Vernonia amygdalina*; d for Afang: *Gnetum africanum*; and e for scent leaf: *Ocimum gratissimum*).

Figure 3: Fruit items used (f for orange: *Citrus sinensis*; g for pineapple: *Ananas comosus*; h for watermelon: *Citrullus lanatus*; i for cucumber: *Cucumis sativus*; and j for lime: *Citrus. aurantifolia*).

Figure 4: Juice items used (k for five alive; l for chivita active; m for Ribena; n for chivita exotic; and o for chivita happy hour).

Method of Mixtures

Preparation of samples

The five selected vegetables, fruits and fruit juices were acquired from the Niger Delta region. The vegetable samples were thoroughly washed with distilled water, sliced and squeezed to get the liquid of the vegetables and fruits. Afang was grinded to obtain liquid content. The work flow of this research is summarized in Figure 5.

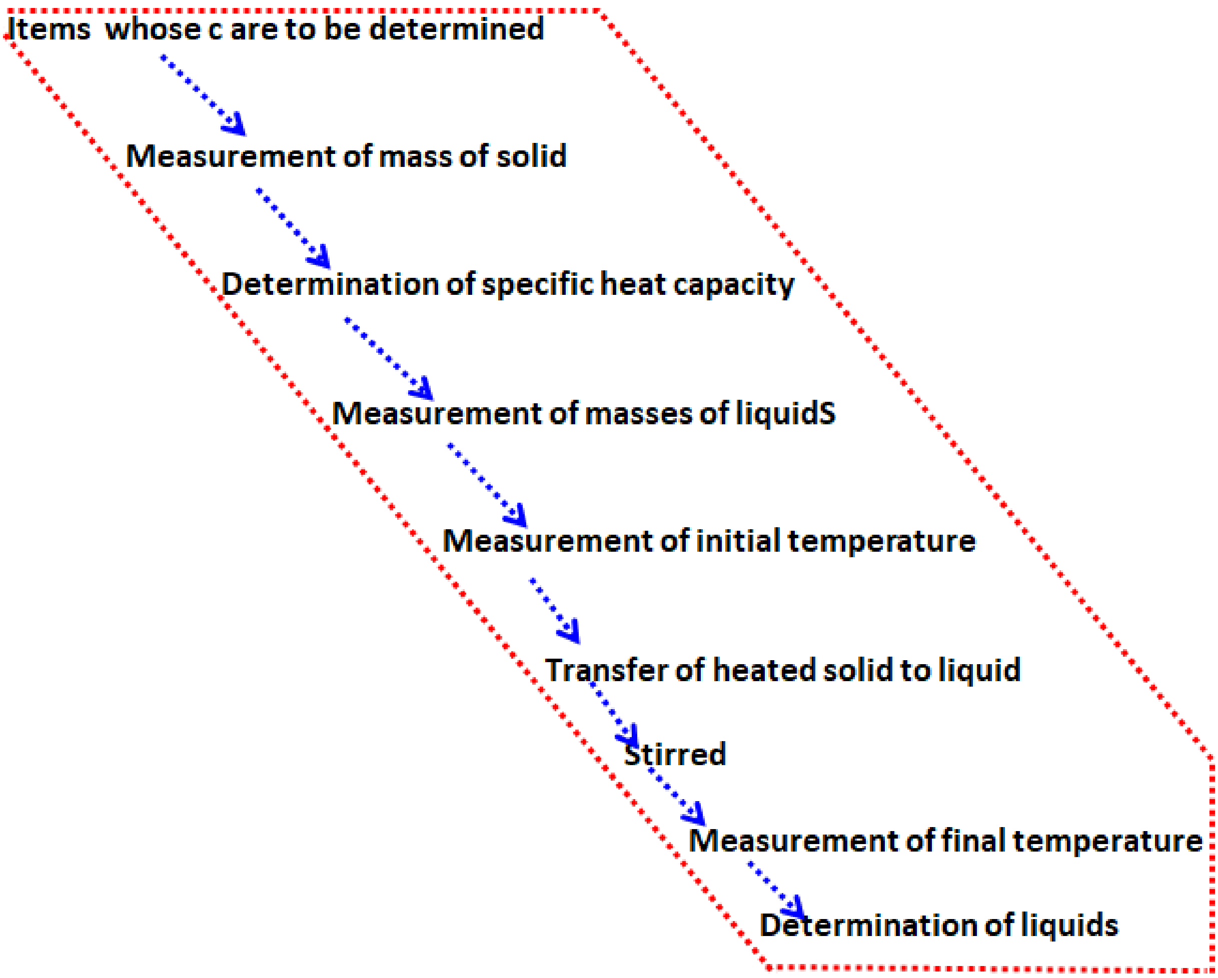

Figure 5: Measured parameters work flow.

Measured parameters include

Mass of solid (m_S) and intake items in kg
Mass of calorimeter (m_C) in kg
Mass of calorimeter with water (m_W) in kg
Temperature of calorimeter with water (T_W) as well as one with other liquids in kg
Change in temperature (ΔT) in ^{0}C
C_S is the specific heat capacity of the solid, C_W that of water and C_C specific heat of calorimeter, then

RESULT ANALYSIS AND DISCUSSIONS

Results

The determination of specific heat capacity of different consumable items has been determined. The result is presented in Figures 6, 7, 8, and 9. Table 1 has the results of measured parameters which enabled the achievement of the goal of this research.

Table 1: Data obtained measured parameter

$m_S(kg)$	$m_C(kg)$	$m_W(kg)$	T_W(°C)	(ΔT)°C	Sample
0.03000	0.06000	0.36	32	10.0	Afang
0.03000	0.10000	0.36	32	6.0	Pumpkin leaf
0.02529	0.07885	0.36	32	4.0	Bitter leaf
0.02529	0.07850	0.36	32	3.0	Scent leaf
0.02529	0.08093	0.36	32	3.0	Water leaf
0.03000	0.10000	0.36	32	5.0	Cucumber
0.03000	0.11000	0.36	32	4.0	Lime
0.03000	0.12000	0.36	32	4.0	Pineapple
0.03000	0.11000	0.36	32	4.0	Watermelon
0.02529	0.08171	0.36	32	3.0	Orange

0.02529	0.08720	0.36	32	2.5	Watermelon white
0.02529	0.08370	0.36	32	4.0	Water melon red
0.03000	0.12000	0.36	32	4.0	Five Alive
0.02529	0.08734	0.36	32	4.0	Chivita Active
0.02529	0.08672	0.36	32	4.0	Chivita Happy hour
0.02529	0.08464	0.36	32	5.0	Ribena
0.02529	0.08834	0.36	32	3.0	Chivita Exotic

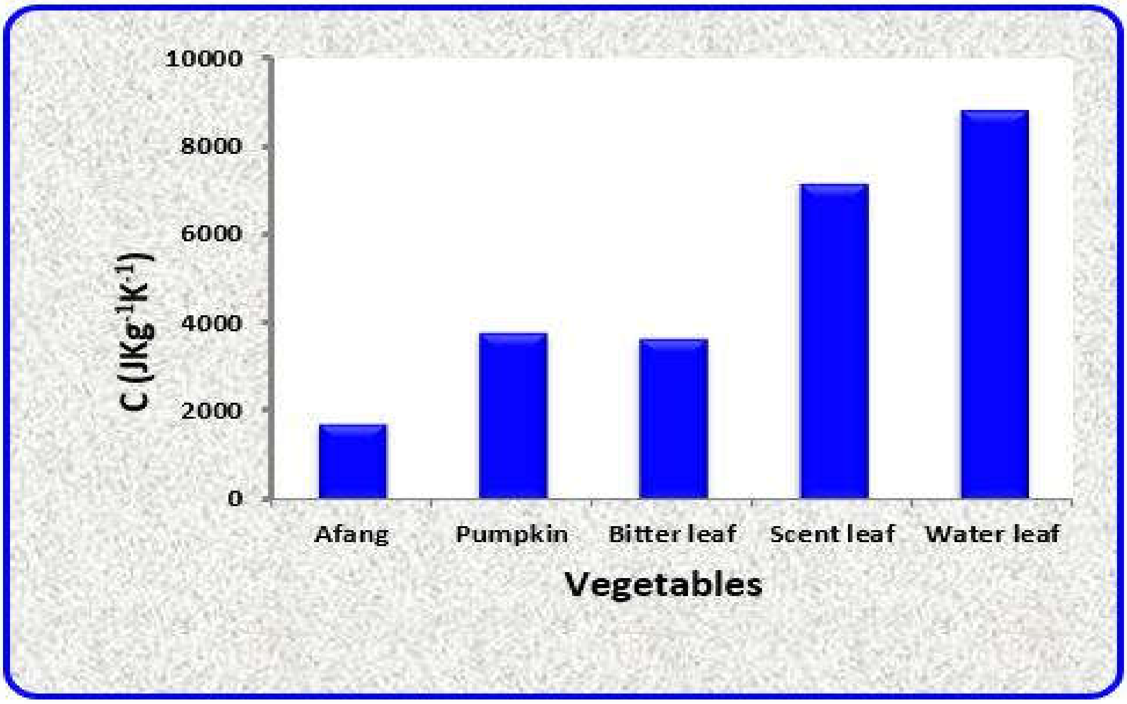

Figure 6: The bar chart of specific heat capacity of vegetables

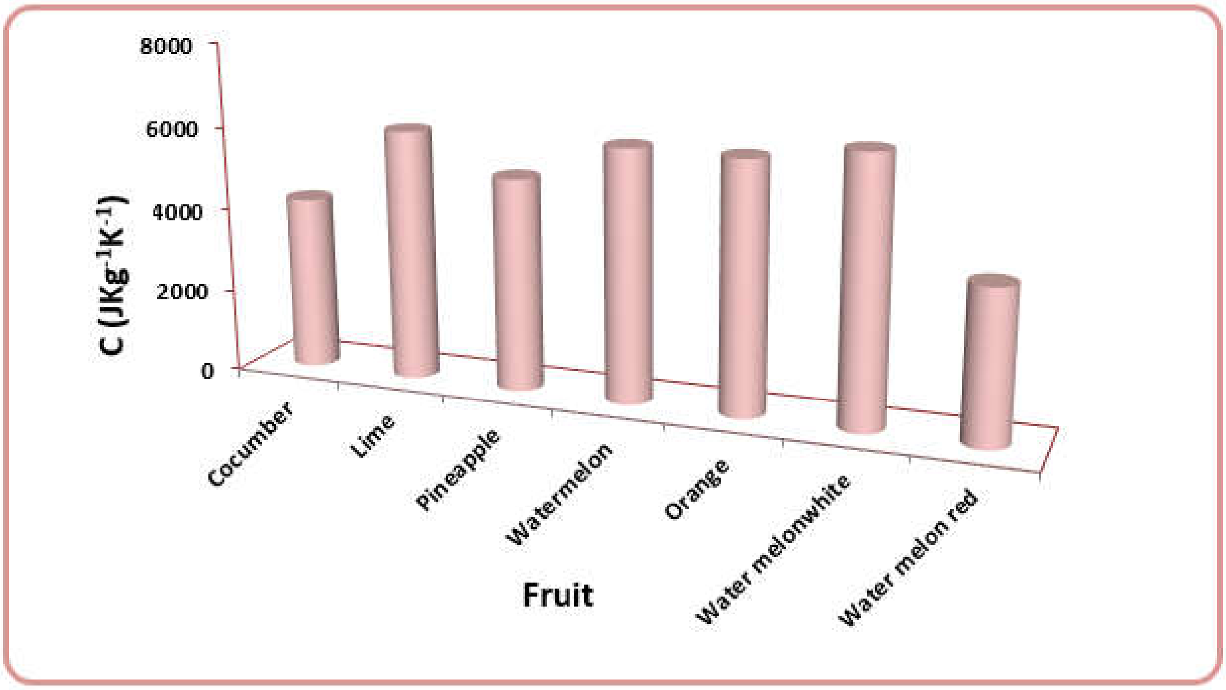

Figure 7: Specific heat capacity results of fruits

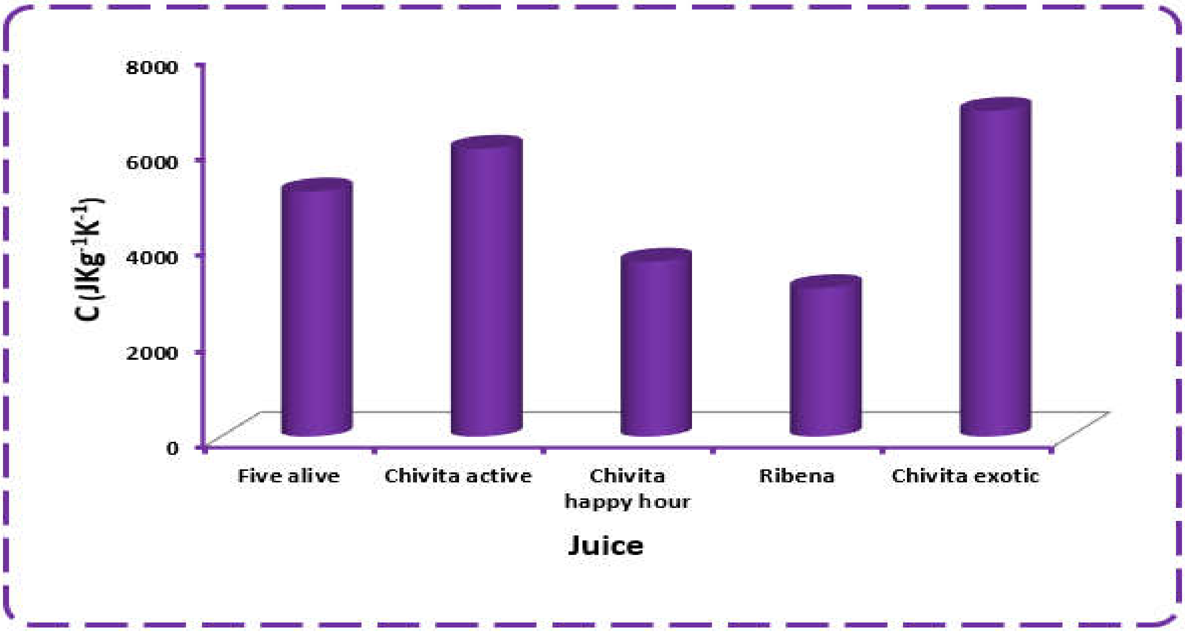

Figure 8: Variation of different juice with their specific heat capacity

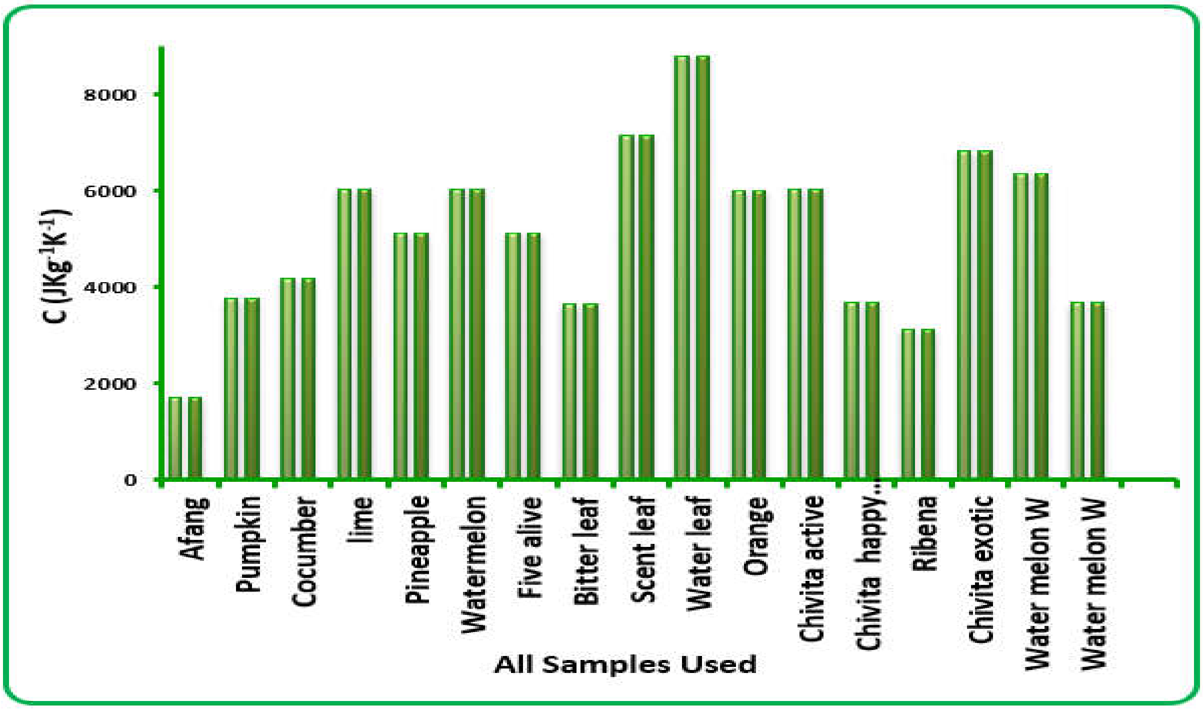

Figure 9: Specific heat capacity of all food intake items investigated

DISCUSSION

The specific heat capacity of a liquid such as water is what enables oceans to absorb energy and assist stabilizing planet livable conditions. It also enables warm blooded animals such as humans to maintain body temperature. Water takes a lot of solutes to change its boiling point or freezing point which it makes stable as a solvent for moving required nutrients throughout the body as it is part of the component of our blood. However, there are many humans who are suffering from internal heat and are advised to consume less internally generated heat food intake. As such it becomes necessary to investigate the specific heat capacity of other food intake like vegetables liquid (Scent leaf, Afang, Waterleaf, Pumpkin, Bitter leaf), liquids from fruits (Orange, Cucumber, Watermelon, Pineapple, Lime) and processed juice like (Ribena, Five alive, Chivita Happy Hour, Chivita Exotic, Chivita Active) which are common food intake by man on daily basis. The specific heat capacities of these intake items were determined using Equation 5 after measured parameters have been obtained. These measured parameters are presented in Table 1. Method of mixtures was adequate for this finding.

Determination of specific heat capacity of vegetables

Figure 6 presents the result of specific heat capacity of different vegetables. The choice of these vegetables is that people in the Niger Delta region, Nigeria, consumed them as one of the sources of food intake on daily basis. Waterleaf has the highest specific heat capacity of 8790.352$JKg^{-1}K^{-1}$, followed by Scent leaf with the value of 7121.063$JKg^{-1}K^{-1}$, Pumpkin is the next with the specific heat capacity of 3752.608$JKg^{-1}k^{-1}$, Bitter leaf has the value of 3619.235$JKg^{-1}k^{-1}$ and lastly Afang with the specific heat capacity of 1679.999$JKg^{-1}k^{-1}$. This means that Afang specific heat capacity is very low and is not good for people with internal heat problems. However, waterleaf with the highest specific heat capacity is recommended for those with internal heat challenges and other humans as it helps the body just like water to maintain the body temperature.

Determination of specific heat capacity of fruits

Fruits are widely eaten all over the world. Figure 7 shows the result of specific heat capacity of different fruits. Some fruits have higher specific heat capacity than the others. The result noted has shown that the white portion of watermelon has the highest specific heat capacity of 6347.037$JKg^{-1}K^{-1}$ than other fruit examined, followed by lime with the value of 6026.086$JKg^{-1}K^{-1}$. The third highest is watermelon when both white and red portions are consumed together; its specific heat capacity is 6026.086$JKg^{-1}K^{-1}$, The next fruit is orange with specific heat capacity of 5993.524$JKg^{-1}K^{-1}$, followed by pineapple whose specific heat capacity is 5113.043$JKg^{-1}K^{-1}$, the next fruit is cucumber with the value of 4163.477$JKg^{-1}K^{-1}$, and lastly the red portion of watermelon with the specific heat capacity of 3657.807$JKg^{-1}K^{-1}$. It is observed that almost all the fruits have better specific heat capacities, although there is a little reduction in specific heat capacity of the red portion of watermelon. Therefore, white portion of watermelon, lime and a whole watermelon are recommended for patients with heat challenges, as this can perform some function performed by water in maintaining the temperature of the body, and also supplies some vital vitamins to the body.

Determination of specific heat capacity of processed juice

Fruit juice is defined as unfermented but fermentable product, intended for direct consumption; obtained by mechanical process from ripe fruits and preserved exclusively by physical means. Figure 8 is the chart of specific heat capacity of different juice. From the result obtained, the chivita exotic has the highest specific heat capacity than other juice examined with the value of 6798.359$JKg^{-1}K^{-1}$, followed by chivita active with the specific heat capacity of 6003.746$JKg^{-1}K^{-1}$, next is five alive, with the value of 5113.043$JKg^{-1}K^{-1}$, followed by chivita happy hour with the specific heat capacity of 3650.246$JKg^{-1}K^{-1}$, and lastly is the ribena with the specific heat capacity of 3101.568$JKg^{-1}K^{-1}$.

Therefore, the most selected recommended juice for the maintenance of healthiness of the body are chivita exotic, chivita active, and also five alive. These juices help in the growth of the body system.
Figure 9 gives the summary of the specific heat capacity of all the Items. Out of the 15 samples, waterleaf has the highest specific heat capacity, which is highly recommended. Afang has the lowest specific heat capacity, it is not good for the human system that is facing internal heat challenges.

CONCLUSION

This research has been conducted to determine the specific heat capacities of liquids from different consumable items. The liquid with the highest value is one from waterleaf and one with the lowest value is from liquid obtain from Afang. Specific heat capacities of other items are not really away from the specific heat capacity of water. These items are sufficient in vitamins and minerals and can maintain body temperature. Afang should not be consumed by persons with internal heat challenges. Waterleaf is strongly recommended for patients with internal heat problem on daily basis.

Conflict of interests

There are non-conflicts of interest.

REFERENCES

[1] Akpabio, I. O., Atat, J. G. and Akankpo, A. O. (2023). Local Fit Parameter Satisfying Shear Modulus Porosity Relation for Southern Z Basin Analysis. *Neuroquantology*, 21(5), 1385-1391.

[2] Atat, J. G. and Umoren, E. B. (2016). Assessment of Mechanical and Elastic Properties of Soils in the South Eastern Part of Niger Delta, Nigeria. *World Journal of Applied Science and Technology*, 8(2), 188-193.

[3] Atat, J. G., Akankpo, A. O., Umoren, E. B., Horsfall, O. I. and Ekpo, S. S. (2020e). The Effect of Density-velocity Relation Parameters on Density Curves in Tau (τ) Field, Niger Delta Basin. *Malaysian Journal of Geosciences (MJG)*, 4(2), 54-58.

[4] Atat, J. G., Akpabio, G. T., George, N. J. and Umoren, E. B. (2012). Geophysical Assessment of Elastic Constants of Top Soil using Seismic Refraction Compressional Velocities in the Eastern Niger Delta. *International Journal of Modern Physics,* 1(1), 7 – 19.

[5] Atat, J. G., Akpabio, I. O. and Ekpo, S. S. (2022). Percentile-Oqive Approach Determines the Textural Parameters of Xa Field Lithology and the Suitable Technique for Porosity Estimates. *Journal of Current Science.* 2(5), 230-240.

[6] Atat, J. G., George, N. J. and Atat, A. G. (2020a). Immediate settlement of footing using interpreted seismic refraction geoelastic data: a case study of Eket county, Nigeria. *NRIAG Journal of Astronomy and Geophysics*, 9(1), 433-448.

[7] Atat, J. G., Horsfall, O. I. and Akankpo, A. O. (2020d). Density Modelling from Well Analysis of Fields [Sand API< 75 and Shale API> 75], Niger Delta Basin. *IOSR Journal of Applied Geology and Geophysics*, 8(2), 1 – 6.

[8] Atat, J. G., Uko, E. D., Tamunobereton-ari, I. and Eze, C. L. (2020b). Site-Dependent Geological Model for Density Estimation in the Niger Delta Basin, Nigeria. *Malaysian Journal of Geoscience*, 4(1), 1-6.

[9] Atat, J. G., Uko, E. D., Tamunobereton-ari, I. and Eze, C. L. (2020c). The Constants of Density-Velocity Relation for Density Estimation in Tau Field, Niger Delta Basin. *IOSR Journal of Applied Physics*, 12(1), 19-26.

[10] Ekpo, S. S., Osahon, O. D., Atat, J. G. and Umar, S. (2021). The Effect of Exploration Activities on Mineral Elements in Fluted Pumpkin Leaves. *IJRDO Journal of Biotechnology*, 1(1), 1-11.

[11] Ekpunobi, U. E., Ukatu, S. C., Ngene, B., O. Onyema, C. T. and Ofora, P. U. (2014). Investigation of the Thermal Properties of Selected Fruits and Vegetables. *American Journal of Science and Technology*, 1: 293–297.

[12] Feidt, M. (2017). *Finite Physical Dimensions Optimal Thermodynamics 1*. First Edition, Elsevier, United Kingdom. Pp1-41.

[13] Gautam, S., Kolesnikov, A. I., Rother, G., Dai, S., Qiao, Z.-A., and Cole, D. (2018): Effects of Confinement and Pressure on the Vibrational Behavior of Nano Confined Propane. *Journal of Physical Chemical*. 122, 6736–6745.

[14] George, N. J., Akpan, A. E., George, A. M. and Obot, I. B. (2010). Determination of Elastic Properties of the Over Burden Materials in Parts of Akamkpa, Southern Nigeria using Seismic Refraction Studies. Archives of Physics Research, 1(2), 58 – 71.

[15] George, N. J., Atat, J. G., Udoinyang, I. E., Akpan, A. E. and George, A. M. (2017). Geophysical Assessment of Vulnerability of Surficial Aquifer in the Oil Producing Localities and Riverine Areas in the Coastal Region of Akwa Ibom State, Southern Nigeria. *Current Science*, 113(3), 430-438.

[16] Hospers, J. (1965). Gravity Field and Structure of the Niger Delta, Nigeria, West Africa. Geological Society of American Bulletin, 76, 407 – 422.

[17] Khalid, U., Nosheen, F., Asif Raza, M., Ishaque, M., Ahmad. M., Ahmad, S. R. and Rubab, F. (2011). A Comparative Study about the Daily Intake of Fruits and Vegetables among Female Students of Two Universities of Faisalabad. Pakistan Journal of Nutrition, 10(7), 684-689.

[18] Klett, T. R., Ahlbrandt, T. S., Schmoker, J. W. and Dolton, J. L. (1997). Ranking of the World's Oil and Gas Provinces by Known Petroleum Volumes. United State Geological Survey Open-File Report, 97, 463.

[19] Liu, R. H. (2003). Health benefits of fruit and vegetables are from additive and synergistic combinations of phytochemicals. American Journal of Clinical Nutrition, 78(3), 517S-520S.

[20] Mercan, H., Celen, A. and Taner, T. (2022). *Thermophysical and Rheological Properties of Unitary and Hybrid Nanofluids*. Elsevier, Amsterdam.

[21] Nagoe, A., Oguni, M., and Fujimori, H. (2015). Low-Temperature Heat Capacities of Confined Liquid Benzene, Implying the Behavior of Ordinary Bulk Liquids. *Journal of Physical Condense. Matter* 27, 455103. doi:10.1088/0953-8984/27/45/455103.

[22] Nagoe, A., Oguni, M., and Fujimori, H. (2015). Low-Temperature Heat Capacities of Confined Liquid Benzene, Implying the Behavior of Ordinary Bulk Liquids. *Journal of Physical Condense. Matter* 27, 455103. doi:10.1088/0953-8984/27/45/455103.

[23] Oladipo, V. O., Adedoyin, A. D. and Atat, J. G. (2018). The Geostatistical Investigation of Grain Size and Heavy Minerals of Stream Sediments from Agunjin Area, Kwara State. World Journal of Applied Science and Technology, 10(1B): 249 – 257.

[24] Reijers, T. J. A., Petter, S. W., and Nwajide, C. S. (1996). The Niger Delta basin: Reijers, T. J. A., ed., Selected Chapter on Geology: SPDC Wa.: LP1O3-118.

[25] Rethaiaa, A. S. A., Alaa-Eldin Fahmy A., and Naseem Al-Shwaiyat, M. (2010): Obesity and Eating Habits Among College Students in Saudi Arabia. A Cross Sectional Study. *Nutrition Journal*, 9, 39.

[26] Roque, N. (2006). Why we Need to Eat Fruits and Vegetables. Ezine Articles, New York.

[27] Smith, J. and Johnson, A. (2018). Experimental Determination of Specific Heat Capacities of Common Substances at Different Temperatures. *Thermodynamics Research*, 25, 45-62.

[28] Steeneveld, G. J., Koopmans, S., Heusinkveld, B. G., and Theeuwes, N. E. (2014). Refreshing the Role of Open Water Surfaces on Mitigating the Maximum Urban Heat Island Effect. *Landscape Urban Planning*. 121, 92–96.

[29] Sun, C., Zhou, R., Zhao, Z., and Bai, B. (2020). Nanoconfined Fluids, What Can We Expect from Them? *Journal of Physical Chemical Lettuce*, Pp 4678–4692.

[30] Tombari, E., Salvetti, G., Ferrari, C., and Johari, G. P. (2005). Heat Capacity of Water in Nanopores. Journal of Chemical Physics 123, 214706. doi:10.1063/1.2131063.

[31] Umoren, E. B., Akankpo, A. O., Udo, K. I., Horsfall, O. I., Atat, J. G. and Asedegbega, J. (2020). Velocity-Induced Pitfalls in Pore Pressure Prediction: Example from Niger Delta Basin, Nigeria. *IOSR Journal of Applied Geology and Geophysics*, 8(1), 52 – 58.

[32] Umoren, E. B., Uko, E. D., Tamunobereton-Ari, I. and Israel-Cookey, C. (2019). Seismic Velocity Analysis for Improved Geopressure Modelling in Onshore Niger Delta. International Journal of Advanced Geosciences, 7(2), 179-185.

[33] Yahia, N., Achkar, A., Abdallah A. and Rizk, S. (2008). Eating Habits and Obesity among Lebanese University Students. *Nutrition Journal*, 7: 1-6.

[34] Zalba, B., Mar铆n, J. M., Cabeza, L. F., and Mehling, H. (2003). Review on Thermal Energy Storage with Phase Change: Materials, Heat Transfer Analysis and Applications. *Applied Thermal Engineering,* 23(3), 251-283.