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ADVANCING SCIENCE AND TECHNOLOGY

Everyday SCIENCE For Schools

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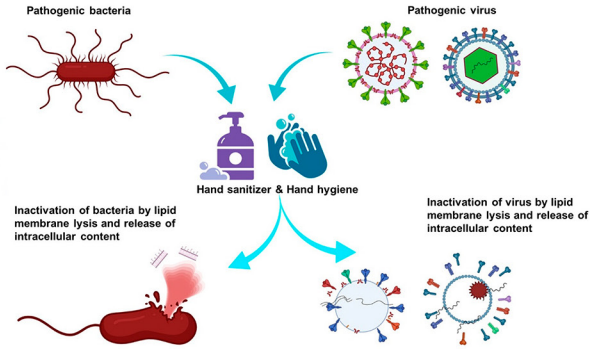

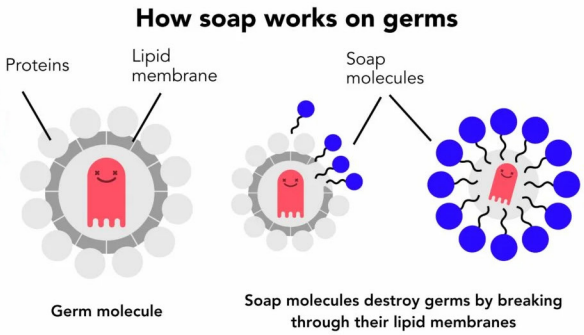

"Hand hygiene is the first basic step towards achieving any millennium goals for development. It saves lives."
— Kajol

“Hand hygiene is the first basic step towards achieving any millennium goals for development. It saves lives.”

— Kajol —

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Ghana Science Association

Introduction

The Ghana Science Association (GSA), a voluntary, non-profit making and multidisciplinary organisation of scientists, technologists and mathematicians was formed in 1959. The Association traces its origin to the West African Science Association (WASA) which was formed in 1953 at the University College of the Gold Coast. WASA was formed to provide West African scientists the forum to advocate the importance of Science and Technology as a necessity and bedrock for national development. The formation of GSA broadened the scope of activities from reading of scientific papers to involvement in national and international affairs. The Association was placed on government subvention under the Ministry of Education as far back as 1961 by a Presidential Fiat. Hence the Association is supported through a budgetary allocation from the Ghana Government. Other sources of income include membership dues and proceeds from workshops and conferences. The GSA was mandated to promote, popularize and demystify science and create a scientific culture in the country. The Association has made tremendous contributions to National Development, Health and Economic Growth through scientific interventions. The Secretariat is a point where scientific and technological information and research findings are obtained by individuals and corporate bodies.

Membership of the Association is drawn from the Universities, Research Institutes, Industry, Government and Persons interested in the promotion of Science and Technology.

Vision and Mission

Vision

To become a dominant voice in Science and Technology advocacy by promoting and popularizing Science and Technology to meet national developmental needs.

Mission

Advancing Science, Technology, Engineering and Mathematics (STEM) through interaction and cross-fertilization of ideas of all interested people to: -

1. Popularize, promote and disseminate scientific information and technology transfer for national development.
2. Contribute to the development of National Science and Technology policy.
3. Collaborate with industry to set national research agenda.
4. Establish linkages with industry to promote the transfer and application of Science.
5. Seek affiliation and foster cooperative links with other national and international organizations.

Activities

1. Organization and participation in scientific conferences, workshops, seminars, symposia, public lectures, quizzes and science fairs.
2. Promotion of carrier development of scientists in Universities and Research Institutes in Ghana and elsewhere.
3. Publication of the scientific journal, magazines and books (e.g. Journal of the Ghana Science Association and Everyday Science for Schools magazine).
4. Training programmes for mathematics and science teachers to improve the teaching and learning of these subjects in Schools and Colleges of Education.

Contribution to National Development

Issues of national importance have been regularly and consistently highlighted at biennial workshops, conferences etc. Communiqués had been submitted to Government and other stakeholders on very topical themes to help shape national policies.

Articles

DIABETIC EYE DISEASE

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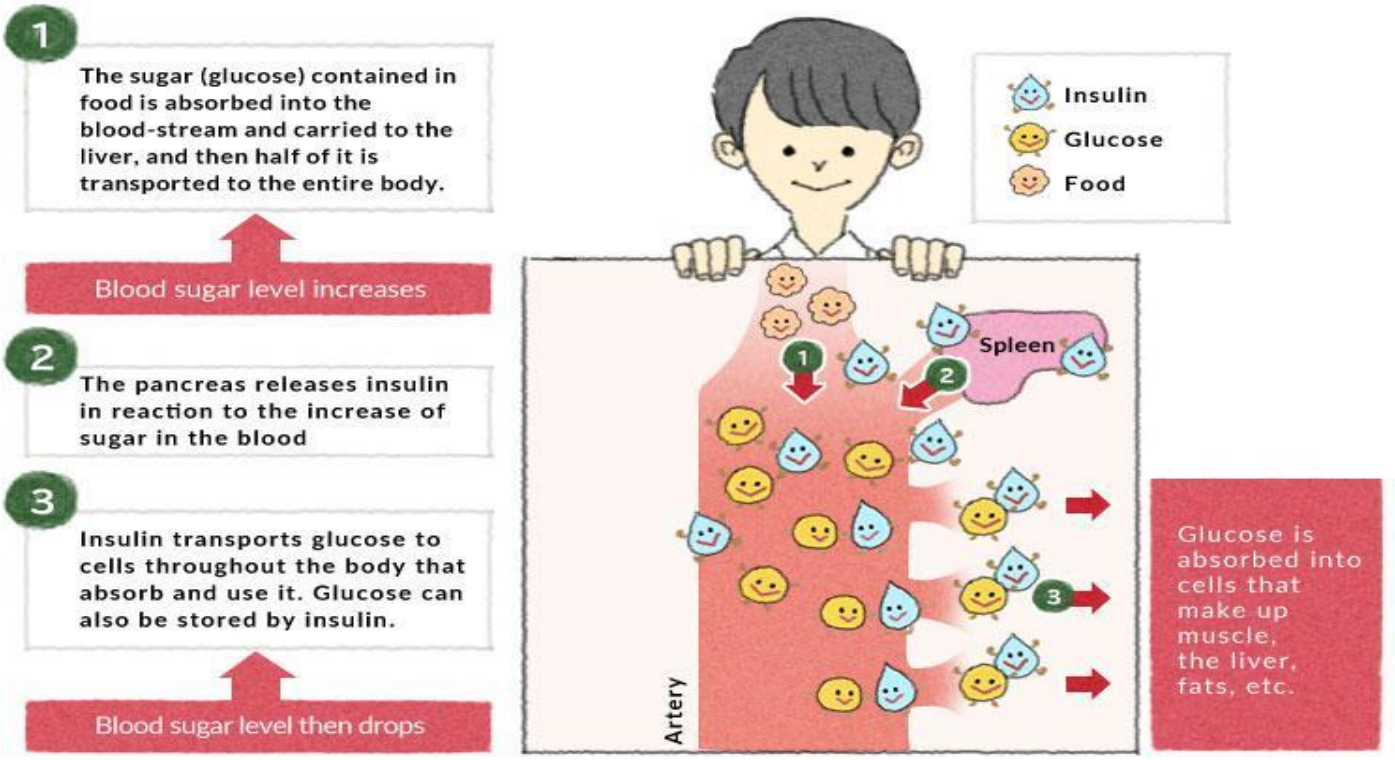


Introduction

When food is taken into the body, the body breaks most of the food into sugar (glucose) and releases it into the bloodstream. The sugar released into the bloodstream signals the pancreas to release insulin which facilitates the entry of the released sugar into the body cells to be used as energy.

With diabetes, the body is either unable to produce insulin or use it as well as it should. When this happens, that is, when there is not enough insulin or when body cells stop responding to insulin, too much sugar stays in the blood stream and over time, this can cause serious health problems (notably heart, kidney and vision problems)

Globally, the number of people living with diabetes is estimated to be 451 million and this figure is projected to increase to 693 million by 2045 if no committed action is taken (Cho et al, 2017). According to the Centre for Disease Control and Prevention, the number of adults diagnosed with diabetes has more than doubled in the last 20 years.

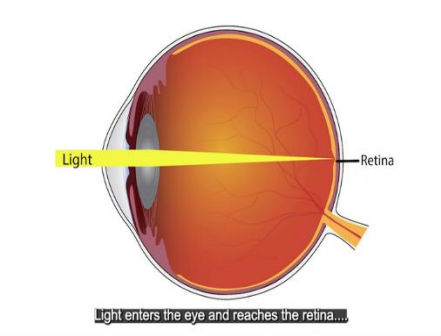
The growing numbers of the cases of diabetes has been attributed to the aging of the global population, urbanization, rising prevalence of obesity and sedentary lifestyles (IDF, 2011).

In sub-Saharan Africa and other developing countries, the prevalence of diabetes is known to have risen more quickly than expected. In Ghana for instance, prevalence rose from 0.2% in 1964 to 1.9% in 2010 and 6.46% in 2018 (Whiting et al, 2011).

What is Diabetic Eye disease?

Diabetic eye disease is simply a term for the several eye conditions that can result from longstanding diabetes. They include but not limited to Diabetic Retinopathy (DR), Diabetic Macular Edema (DME), Cataract, Neovascular Glaucoma.

1. Diabetic Retinopathy:
The retina is the inner lining at the back of each eye. Its role is to sense light and turn it into signals that the brain decodes for us to see the world around us.



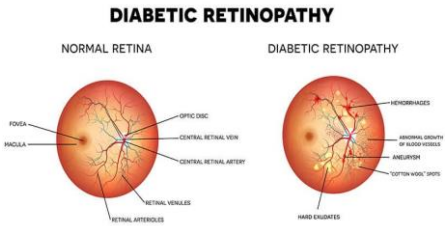
Longstanding diabetes can cause damage to the small blood vessels in the retina and lead to a disease called diabetic retinopathy. DR is therefore a long-term microvascular complication of diabetes on the eye.

Globally, among people living with diabetes, DR has a prevalence of 22.27% and a higher prevalence in Africa being 35.90% (Teo et al, 2021). Among the estimated 3.6% of Ghanaians living with diabetes, 34% have DR while 10% will have vision- threatening DR (IDF, 2017; Yau et al, 2012)

In the early stage of DR, otherwise known as the non- proliferative stage, blood vessels swell or bulge out and become leaky. Progressively, some blood vessels may close off and new blood vessels may grow as a response to perform the activities of the damaged blood vessels. However, these new blood vessels that grow are very weak and leaky. The growth of abnormal new blood vessels is the proliferative stage of the disease.

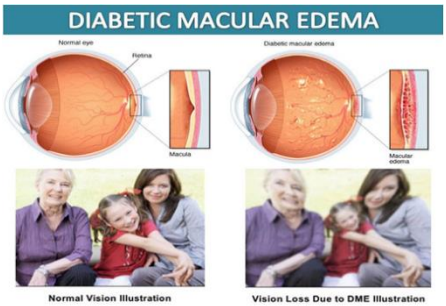
Without early detection and treatment, DR can progress into advanced stages and cause vision threatening conditions such as Diabetic Macular Edema, Retinal Detachment and Neovascular Glaucoma.

Studies have shown that approximately a third of people living with diabetes will develop DR and a third of those with DR will develop vision- threatening DR (Lee et al, 2015).



2. Diabetic Macular Edema (DME)
The Macula is the part of the retina responsible for central vision, that is, when looking straight ahead (reading, driving, writing, etc).
Subsequent to the growth of abnormal leaky blood vessels in the retina, fluid can build up in the macula, causing it to swell (macula becomes edematous). This causes the macula to lose its ability to provide sharp vision, leading to partial or permanent vision loss.

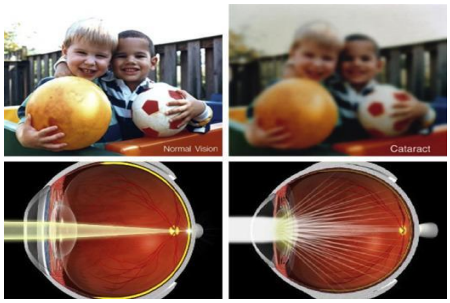
DME is the commonest cause of vision loss among diabetics suffering from DR.



3. Glaucoma
Glaucoma is a group of eye conditions or diseases that cause damage to the optic nerve (the nerve that carries information from the eyes to the brain. The abnormal blood vessels that grow during the proliferative stage of DR can extend to and block the eye's aqueous drainage system, causing aqueous build up, increase in the pressure of the eye (intraocular pressure) and subsequently glaucoma.
This type of glaucoma is called neovascular glaucoma.

4. Accelerated age-related cataract.
The eye has a lens which is a clear structure that helps to bend light reflecting from the things we see onto the retina. Aging typically causes this clear structure to lose its clarity and become cloudy, causing a decrease in vision.

Studies have shown that individuals with diabetes are more likely to develop cloudy lens earlier than those without diabetes.



Other effects of diabetes on vision which are noteworthy include:

1. Diplopia (double vision)

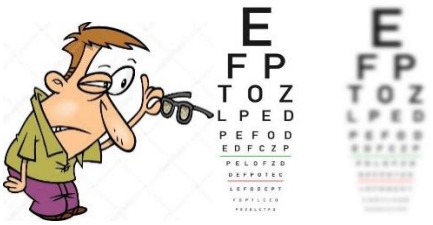
The retina of one eye is made up of several areas or points which corresponds with those of the other eye.

For single vision to occur with both eyes opened (binocular single vision), images falling on one retinal point or area of one eye must correspond with that of the other so fusion can take place for the image to be perceived as one.

One-way binocular single vision can be achieved is through coordinated movement of the muscles of the eye. This ensures that the images fall at corresponding areas or points on either retina.

Diabetes can cause a damage to the nerves that innervate the muscles of the eye resulting in poor coordination of eye movements and diplopia.

2. Unstable Refraction:



Acute hyperglycemia affects the eye's refractive system, causing blurred vision. However, vision is expected to return to normal after stabilizing blood sugar levels.

It is therefore advisable to ensure that blood sugar levels are stable before going in for a new pair of glasses.

Risk factors of diabetic eye disease

1. **Duration of diabetes**
   Diabetic retinopathy rarely develops within 5 years of the onset of diabetes or before puberty, but some type 2 diabetics may have DR at the time of their diagnosis with Type 2 diabetes.
2. **Poor control of diabetes**
   Tight blood glucose control, particularly when instituted early, can prevent or delay the development or progression of diabetic retinopathy.
3. **Hypertension**
   Hypertension is very common in patients with type 2 diabetes and should be rigorously controlled. Tight control appears to be very beneficial.
4. **Kidney/ Renal disease (Nephropathy)**
   Nephropathy, if severe, is associated with worsening of diabetic retinopathy. Conversely, treatment of renal disease may be associated with improvement of retinopathy.
5. **Pregnancy**
   Diabetes during pregnancy is sometimes associated with rapid progression of diabetic retinopathy.
6. Other risk factors include hyperlipidaemia, smoking, cataract surgery, obesity and anaemia.

Treatment and management options

1. Diabetes control should be optimized.
2. Risk factors, particularly systemic hypertension (especially in type 2 diabetes) and hyperlipidaemia should be controlled with other modifiable factors such as anaemia and renal failure addressed as necessary.
3. Smoking should be discontinued.
4. Anti-VEGF therapy
5. Laser treatment or photocoagulation

I already have diabetes. What can I do to prevent diabetic eye disease?

1. Keep your blood glucose levels, hypertension and cholesterol levels in check.
2. Take your medications regularly as prescribed.
3. Follow the right meal plan.
4. Quit smoking
5. Embrace physical activity.
6. Have a dilated eye exam at least once a year or as often as recommended by your eyecare professional.

What if I already have some vision loss from diabetes?

Seek low vision and rehabilitation services.

This will help to maximize your residual vision through special devices and training to enable you remain active and independent.

References

Teo ZL, Tham YC, Yu M, Chee ML, Rim TH, Cheung N, et al. Global Prevalence of Diabetic Retinopathy and Projection Burden through 2045: A Systematic Review and Meta Analysis. Opthalmology. 2021 Nov; 128(11):1580-1591. doi: 10.1016/j.optha.2021.04027.

Asamoah-Boaheng M, Sarfo-Kantanka O, Tuffour AB, Eghan B, Mbanya JC. Prevalence and Risk factors for Diabetes Mellitus Among Adults in Ghana: A Systematic Review and Meta Analysis. Int Health. 2019;11(2):83-92. https://doi.org/10.1093/inthealth/ihy067

Salmon J. (2019) Kanski's Clinical Ophthalmology. 9th Edition, Elsevier, Amsterdam.

Cho NH, Shaw JE, KAruranga S, Huang Y, Da Rocha Fernandes JD, Ohlrogge AW, et al. IDF Diabetes Atlas: Global Estimates of Diabetes Prevalence for 2017 and Projections for 2045. Diabetes Res Clin Pract. 2018; 138:271-81. https://doi.org/10.1016/j.diabres.2018.02.023

IDF. International Diabetes Federation: Diabetes Atlas. 8th ed; 2017.

Lee R, Wong TY, Sabanayagam C. Epidemiology of Diabetic Retinopathy, Diabetic Macular Edema and Related Vision Loss. Eye Vis (Lond). 2015; 2(1):17. https://doi.org/10.1186/s40662-015-0026-2

Yau JW, Rojers SL, Kawasaki R, Lamoureux EL, Kowalski JW, Bek T, et al. Global Prevalence and Major Risk Factors of Diabetic Retinopathy. Diabetes Care. 2012;35(3):556-64. https://doi.org/10.2337/dc11-1909

Whiting DR, Guariguata l, Weil C, Shaw J. IDF Diabetes Atlas: Global Estimates of the Prevalence off Diabetes for 2011 and 2030. Diabetes Res Clin Pract. 2011;94(3):311-21. https://doi.org/10.1016/j.diabres.2011.10.029

IDF Diabetes Atlas. 5th ed. Brussels, Belgium: International Diabetes Federation; 2011.

https://www.cdc.gov/diabetes/basics/diabetes.html. Retrieved on 26th August 2022 at 10:32pm

https://www.who.int/news-room/fact-sheets/detail/diabetes. Retrieved on 26th August 2022 at 10:37pm

https://eye.hms.harvard.edu/diabetes. Retrieved on 26th August 2022 at 10:41pm

https://www.aao.org/eye-health/diseases/diabetic-eye-disease. Retrieved on 26th August 2022 at 10:50pm

https://www.niddk.nih.gov/health-information/diabetes/overview/preventing-problems/diabetic-eye-disease. Retrieved on 28th August 2022 at 8:05pm

https://glaucoma.org/diabetes-and-your-eyesight/. Retrieved on 28th August 2022 at 8:12pm

CHOCOLATE, TYPES AND HEALTH BENEFITS

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Introduction

Chocolate is a confectionery product that is made from cocoa beans and contains fats, proteins, carbohydrates, and polyphenols. The primary ingredients used in making chocolate are cocoa liquor and cocoa butter, although other ingredients like sugar, milk, emulsifiers, and whey powder can be added depending on the type of chocolate being produced (Biehl et al., 2011).

The quality of chocolate is determined by factors like glossiness, texture, aroma, snap, and taste. Chocolate was first cultivated in Mesoamerica, where it was consumed by the Mayas, Incas, and Aztecs. It was considered a luxury item and was primarily accessible to the wealthy. Today, chocolate is widely consumed and sensitive to temperature and humidity (Owusu et al., 2010)

Production of Chocolate

To produce chocolate, the ingredients undergo several processes, including mixing, refining, conching, tempering, molding, and demolding. The mixing process involves blending all the ingredients evenly, while refining is carried out to reduce the particle size of the mixture to less than 30µm. Conching is done by agitating the chocolate at a temperature above 50°C to improve the texture, viscosity, and flavor of the final product. Tempering improves the consistency, hardness, and texture of the chocolate, while molding and demolding are the final stages in chocolate production.

Types of Chocolate and CODEX Standard Requirements

Different types of chocolate are classified according to the proportion of cocoa solids used in the formulation. Some of these types include milk chocolate, dark chocolate, white chocolate, raw chocolate, unsweetened chocolate, bittersweet chocolate, and semisweet chocolate.

Milk chocolate contains milk, while dark chocolate is made using a higher percentage of cocoa solids with butter instead of milk.

White chocolate does not contain cocoa solids but is made from sugar, milk, and cocoa butter. Raw chocolate is unprocessed and not mixed with any other ingredient, while unsweetened chocolate is pure chocolate liquor mixed with fat. Bittersweet chocolate is chocolate liquor with a little amount of sugar, and semisweet chocolate is dark chocolate with half as much sugar as cocoa solids.

Dark chocolate is also known as plain or black chocolate. It is produced using a higher percentage of cocoa solids with butter instead of milk. However, there are also dark milk chocolates. These are produced upon the addition of milk. Dark chocolates can be eaten or used for cooking and baking.

There are codex standard requirements for different types of chocolate in terms of the percentage of various ingredients like cocoa solids, cocoa butter, milk solids, and fat.

Health Benefits of Chocolate

- Antioxidants found in chocolate have been shown to inhibit plasma lipid oxidation. Antioxidants in chocolate could be effective cardiovascular preventive strategy in patients with metabolic disease.
- Chocolate can significantly lower blood pressure. Dark chocolate has been reported to reduce systolic blood pressure in healthy subjects as well as in young and elderly hypertensive patients (Ried, et al., 2009)
- Chocolate has aspirin-lie effects on platelet function. It decreases platelet aggregation and also reduces platelet adhesion. This inhibits platelet activation preventing platelet dysfunction (Latif, 2013)
- Chocolate has several bioactive compounds which promote alertness and alleviate stress. It prompts the production of serotonin, a calming neurotransmitter.
- Chocolate has anti-inflammatory effects. It does so by inhibiting lipoxygenase pathways by directly binding to the active sites of the enzyme lipoxygenase (Latif, 2013)

Table of the codex standard requirement for different types of chocolate.

	STANDARD REQUIREMENT FOR CHOCOLATE IN PERCENTAGE (%)							
Chocolate products	Total cocoa solid	Cocoa butter	Fat-free cocoa solid	Flour or starch (wheat, maize, rice	Milk solids	Milk fat	Total fat	Hazelnuts
Standard chocolate	≥35	≥ 18	≥14					
Chocolate a la taza	≥35	≥18	≥14	<8 m/m				
Sweet chocolate	≥30	≥18	≥12					
Chocolate familiar a la taza	≥30	≥18	≥12	<18m/m				
Couverture chocolate	≥35	≥31	≥2.5					
Milk chocolate	≥25		≥2.5		≥12-14	≥2.5-3.5		
Family milk chocolate	≥20		≥2.5		≥20	≥5		
Milk chocolate couverture	≥25		≥2.5		≥14	≥3.5	≥31	
White cholate		≥20			≥14	≥2.5-3.5		
Gianduja chocolate	≥32		≥8		≤5			≥20 and ≤40
Gianduja milk chocolate					≥10			≥15 and ≤40
Chocolate para mesa	≥20	≥11	≥9					
Semi bitter Chocolate para mesa	≥30	≥15	≥14					
Bitter Chocolate para mesa	≥40	≥22	18					
Chocolate Vermicelli /Chocolate Flakes	≥32	≥12	≥14					
Milk Chocolate Vermicelli / Milk Chocolate Flakes	≥20		≥2.5		≥12	≥3		

(CODEX STAN 87, 1981- Amendment - 2016) Key: ≥ not less than ≤ not more than < less than

References

Alimentarius, C., Standard for chocolate and chocolate products. CODEX STAN, pp.87-1981.

Beckett, S. (2009). Industrial chocolate manufacture and use. John Wiley & Sons.

Biehl, B., Cooper, K. A., & Ziegler, G. R. (2011). Milk chocolate. In Chocolate Science and Technology (pp. 347-372). John Wiley & Sons.

Chocolate Manufacturers Association of the USA. (2013). Chocolate facts and figures. Retrieved from https://www.candyusa.com/wp-content/uploads/2013/12/Chocolate-Facts-And-Figures.pdf

Hernández-Hernández, E., Pinto, M. S., García, M. C., & Gómez-Mascaraque, L. G. (2018). Cocoa and chocolate: Composition, bioavailability, and health implications. Journal of Functional Foods, 44, 254-265.

Latif, R., 2013. Chocolate/cocoa and human health: a review. Neth J Med, 71(2), pp.63-8.

Owusu, M., Petersen, M. A., & Heimdal, H. (2010). A critical review of the sensory and nutritional attributes of chocolate milk. Journal of Food Science, 75(6), R77-R85.

Ried, K., Frank, O.R. and Stocks, N.P., 2009. Dark chocolate or tomato extract for prehypertension: a randomised controlled trial. BMC complementary and alternative medicine, 9(1), pp.1-12.

INFECTION AND IMMUNITY

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Introduction

It is common to hear us talk about germs and how they can be harmful to us. Germs are a part of our everyday life and are found in our air, soil, water, and in and on our bodies (CDC, 2016). Generally, we know that germs cause diseases in humans and animals, and they do so by entering our food, water or coming into direct contact with our hands and other body parts, and eventually get entry into our body system. These germs which invade both human and animal bodies are also called pathogens, whereas the humans and animals that are invaded by the pathogens are called hosts. The branch of science which studies germs is known as microbiology. Thus, the study of the biology of very small organisms (microorganisms) that cannot be seen with the unaided eye. These include bacteria, protozoa, fungi, etc. The movement of these microorganisms from one point to a host is known as transmission. Even though some of these organisms can survive very extreme environmental and weather conditions, they can largely be controlled under strict hygienic practices such as keeping the environment clean, regular bathing with soap, regular washing of hands with soap under running water etc.

Before the knowledge of infection by pathogens, it was thought that diseases occurred by divine means, then in the 19th century, Louis Pasteur developed the germ theory, in which he explained that specific microorganisms were responsible for specific infections (diseases). This was followed by Robert Koch's postulate in which he gave four criteria based on which a microorganism can be said to be responsible for a disease (Segre, 2013). Examples of pathogens which have caused major infections (diseases) globally in recent times are Ebola; caused by the Ebola virus, Covid – 19 Disease; caused by the severe acute respiratory syndrome – Corona Virus – 2 (SARSCoV-2), Cholera; caused by the bacterium vibrio cholerae, Tuberculosis; caused by the bacterium mycobacterium tuberculosis etc.

How does transmission of pathogens occur?

Microorganisms are everywhere (Doron and Gorbach, 2008) including our body surfaces, mouths, nostrils, in our schools, homes, markets, tables, chairs, door handles, cars etc. Some may not be harmful; others may be harmful. They are transmitted to humans and animals through air, water, food, or living vectors. Thus, pathogens may get entry into their hosts when the former is brought into direct contact with the latter by air in the form of droplets, or by vectors, and any medium serving as a vehicle. When we walk in contaminated environments like, refuse dump, unkept toilet and lavatories, our shoes or sandals or even our cloths are likely to pick pathogens from these environments. Our shoes, sandals, cloths and other household equipment that can pick pathogens are called fomites. A fomite may be described as an inanimate object that can serve as a vehicle to move a pathogen from one location to another. Our bodies may also pick directly pathogens from surfaces like door handles, benches, desks, car gates, car seats etc. or even from fomites. These pathogens may enter our body system through any available opening such as cuts or wounds, eyes, nostrils, mouth etc. For example, when our hands are contaminated with pathogens, and we introduce a finger from the same hand which is likely contaminated too because it is part of the hand, into our nose, we are directly transferring the pathogen into our body system through the nose. Same when we put contaminated fingers into our mouth, eyes or even play with the opening from the urethra (meatus) etc. Some pathogens may also be transmitted from one host to another through exchange of body fluid such as semen, saliva, blood etc. We therefore become the vehicle to transport these pathogens from one location to another. As we move further around after picking the pathogens, we spread them (pathogens) directly when we come in contact with other potential hosts or indirectly to new locations and they become available for new hosts.

How does infection occur?

According to the Centre for Disease Control (2016), an infection occurs when germs enter the body of a host, increase in number, and provokes a reaction from the body. Once the pathogen enters a host, it needs first to establish itself, like a young man settling for life. It then begins to multiply. The entry of the pathogen into the body system of a host, is quickly recognized by the host's system known as immune system. The US National Cancer Institute defines the immune system as a complex network of cells, tissues, organs, and the substances they make that helps the body fight infections and other diseases. The immune system is categorized into an innate system (from birth) and

an acquired system. At this stage, a battle is stagged between the pathogen and the immune system. The pathogen by their activities may cause damage to the cells of the host, or may produce poisons that may harm the cells, and this may manifest in signs and symptoms of a disease in the host.

References

Centre for Disease Control and Prevention. How Infections Spread, Infection Control. https://www.cdc.gov/infection-control/spread/index.html (Accessed on 14th, July 2022)

Doron, S., & Gorbach, S. L. (2008). Bacterial infections: overview. International Encyclopedia of Public Health, 273.

Segre, J. A. (2013). What does it take to satisfy Koch's postulates two centuries later? Microbial genomics and Propionibacteria acnes. Journal of Investigative Dermatology, 133(9), 2141-2142

US National Institute of Health, National Cancer Institute. Definition of immune system - NCI Dictionary of Cancer Terms - NCI" https://www.cancer.gov/publications/dictionaries/cancer-terms/def/immune-system (Accessed on 14th, July 2022)

THE EFFECTS OF CLIMATE CHANGE ON MAIZE PRODUCTION IN GHANA

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Figure 1: picture showing the effect of drought on maize plants.

Abstract

Climate change has been one of the main challenges to Ghana's socio-economic development. This has negatively affected the agricultural productivity of the country as a result of the changes in factors such as rainfall, temperature, sunshine, and humidity, leading to a decrease in food production. Because maize plays such an important role in the country's food industry, several studies have been conducted to determine which climatic factors have a substantial impact on maize production in Ghana. It is revealed in pieces of literature that temperature and rainfall are the two major climatic factors that affect maize production most in Ghana.

Future increase in atmospheric temperatures and a reduction in the amount of rainfall has been projected to be high across Ghana by most researchers. This is likely to affect maize production across the country and also food security, it is making it difficult for Ghana to achieve its SDGs on food security by 2030. It is projected that maize production in Ghana is likely to be reduced from 19% to 14% by the end of 2050.

Several adaptation measures have been recommended to be adopted by farmers to help improve maize production. These include the planting of drought and heat-resistant maize varieties, early planting of maize, training of farmers on the use of irrigation materials, practicing farming methods that can help to conserve soil water, and others.

Introduction

Climate change refers to a long-term shift in temperatures and other weather conditions (Kahn et al., 2021). Globally, changes in temperature and other weather conditions cause the production of heat-trapping gases such as carbon dioxide, fossil fuels, oil, and LPG. This shift can be natural, but since 1900, human activities have been the main driving force for climate change, primarily due to the burning of fossil fuels, such as coal changes in the patterns of rainfall. Over the last two decades, there has been an increase in the global average temperature of the earth's surface by 2.12 degrees Fahrenheit or 1.18 degrees Celsius. Between 1993 and 2019, there was an annual loss of 279 billion tons of ice in some parts of the world, as ice sheets break off and eventually melt, as a result of an increase in temperatures in such areas (Provant et al., 2021). One important worry about climate change has to do with its disastrous impact on agriculture and food security in some parts of the world, more importantly in developing countries such as Ghana.

Globally, about 70% of people in developing countries live in rural communities, where agriculture is their main source of livelihood, and Africa is no different (Buheji et al., 2020). Climatic conditions such as temperature, rainfall, humidity, sunshine, and others impose a direct threat on agriculture (Nawaz, Khan, Hafiz, Khan, & Khalid, 2021).

These climatic conditions have become the sole determiners of vegetative growth and animal production. Studies have shown that agricultural productivity is likely to be decreased due to an increase in atmospheric temperatures of about 1- 2◦C in Africa.

In the global world, changes in cool regions have the potential for an increase in food production with an increase in the local average temperature of between 1 and 3 degrees Celsius (Malhi, Kaur, & Kaushik, 2021). This means that in the cool regions, the moderate temperature will be beneficial to cereals such as maize production. This climate change, therefore, exerts a series of stress on the biophysical as well as the social environment that supports agricultural production, thus thwarting the effort of farmers and causing a threat to food production and the production of livelihood (Bandh, Parray, & Shameem, 2022).

Agriculture as the backbone of the Ghanaian economy is highly sensitive to climate change and its variability between different ecological zones. The sector comprises approximately 30% of Ghana's GDP to date and employs close to about 50% of the population (Gaddis, Oseni, Palacios-Lopez, & Pieters, 2020). The agricultural sector is believed to have the potential to grow at a fast rate of 6% per annum (Petersson et al., 2022), but climate change could potentially affect such progress in the long run, given that the sector is particularly vulnerable to this phenomenon (Petersson et al., 2022). Climate change has a negative thread on Ghana's effort to achieve the Millennium Development Goals to ensure food security by 2030 (Echendu, 2022). The vulnerability of Ghana's agriculture to climate change is largely due to its dependence on rainfall, particularly in the northern part of Ghana. Within the agricultural sector of Ghana, maize production is seen as the highest cultivated crop most especially in the northern part of Ghana (Cudjoe, Antwi-Agyei, & Gyampoh, 2021). Maize production in Ghana also constitutes about 62% of the total production of grains and their consumption throughout the country (Dabija, Ciocan, Chetrariu, & Codină, 2021).

Objectives of the Study

The main objective of this review is to gather information on the projected effects of climate change on maize production in Ghana and to identify different measures of adaptation to combat the effects.

Current Effects of Climate Change in Ghana

Literature has provided empirical evidence that climate change has caused a significant negative economic effect on Ghana's agriculture. As such, cereal products such as maize in Ghana have been lower as compared to other developed countries and this has called for agent attention to ensure food security in Ghana. Studies have reported that temperature has been the major threat to agricultural production in Ghana among all other atmospheric conditions, more importantly in the northern part of Ghana (Ali, Agyekum, & Adadi, 2021).

It is reported that there has been a significant reduction in maize yield across the northern part of Ghana and temperature and rainfall are the major contributing factors that affect maize production in the northern part of Ghana. Also, the quality of soil has a significant contribution to the net revenue per hectare of maize yield (Obour, Arthur, & Owusu, 2022). Other studies have also reported that maize production within the Coastal savannah has declined over the last 20 years. This was due to lower rainfall patterns across the coast.

Other studies within the Ejura-Sekyeredumasi Municipality in the Ashanti Region of Ghana also reported that there has been a significant change in weather conditions such as temperature and rainfall over the years. It was noted that these changes pose a great impact on crop production such as maize.

Also, other studies have shown that delay in the onset of rainfall results in a delayed planting of maize and this leads to reduced maize yield in most parts of Ghana. It is also noted that the decline in maize yield in most parts of Ghana is a result of an increase in temperatures (Etwire, Koomson, & Martey, 2022). It is also projected that temperatures are likely to be increased between 1.3 to 1.6 degrees Celsius by 2050, and this will cause a further decline in the yield of maize production.

Figure 2: Effects of Climate Change in Ghana

The Potential Effects of Climate Change on Maize Production on Ghana

Some studies have suggested that maize production is going to be greatly lower across Ghana shortly (Wongnaa et al., 2021). It is noted that maize production across Ghana is going to be reduced by 14% to 19% due to an increase in temperature and reduced precipitation (Cudjoe et al., 2021). Other authors are of the view that future rainfall will be reduced, and this will pose a great impact on soil moisture which will cause a significant reduction in maize production in Ghana. Also, it is revealed from several studies that there is a projected increase in atmospheric temperatures due to due human activities such as deforestation, industrial activities, and others (Prakash & Verma, 2022).

Climate Change Adaptation in Maize Production in Ghana

So many adaptation procedures have been cited by various authors on the effect of climate change on maize production in Ghana. Farmers within the semi-arid zones of Ghana are advised to plant new crops with specific genetic traits that are resistant to some atmospheric conditions (Ayuba et al., 2021).

Other studies suggested early planting of maize, land fallowing, and the inclusion of cowpea as a mechanism for adaptation against climate change to improve maize production in Ghana (Etwire et al., 2022). Farmers within the northern part of Ghana are advised to practice crop rotation and row planting as climate change adaptation strategies to improve maize production. Projections show that there will be a reduction in the amount of rainfall in the semi-arid zones of Wa between 2050 and 2080. It also indicates that atmospheric temperatures within these areas are likely to be increased by 2.0 degrees Celsius and 3.9 degrees Celsius respectively between 2046 and 2065.

Figure 3: Climate Change and Maize Production in Ghana.

Conclusions

The negative effects of climate change on maize production have been reviewed in this paper. Various findings and conclusions have been drawn by so many researchers about the future projection of climate change and its adaptation strategies. Common among them is the continuous increase in atmospheric temperatures, which can have a great impact on maize production across Ghana. It is also concluded that there will be a significant reduction in the rainfall pattern across Ghana and this will bring about a decline in maize yield across the country.

As part of the measures to combat the effect that climate change has on maize production, several adaptation measures have been suggested to enable farmers to overcome the impact of climate change. Farmers are advised to practice irrigation activities on their farmlands to ensure a constant supply of water to their crops. It is also suggested that farmers should adopt different methods of conserving soil water on their farms by practicing cover cropping. Farmers are also advised to practice different farming systems that can help to improve soil fertility, such as fallowing, crop rotation, row planting, and others.

Recommendations

In this review, some recommendations are suggested including the following; farmers should cultivate an improved variety of maize that is resistant to heat. Farmers should also cultivate maize varieties that are resistant to drought and have a short maturity period. Farmers should also devise different ways of conserving soil water such as cover cropping and mulching of farmlands. Farmers should be trained on how to use irrigation materials to ensure a constant supply of water to their farms.

References

Ali, E. B., Agyekum, E. B., & Adadi, P. J. S. (2021). Agriculture for sustainable development: A SWOT-AHP assessment of Ghana's planting for food and jobs initiative. 13(2), 628.

Ayuba, J., Jaiswal, S. K., Mohammed, M., Denwar, N. N., Dakora, F. D. J. S., & Microbiology, A. (2021). Adaptability to local conditions and phylogenetic differentiation of microsymbionts of TGx soybean genotypes in the semi-

arid environments of Ghana and South Africa. 44(6), 126264.

Bandh, S. A., Parray, J. A., & Shameem, N. (2022). Climate Change and Microbial Diversity: Advances and Challenges.

Buheji, M., da Costa Cunha, K., Beka, G., Mavric, B., De Souza, Y., da Costa Silva, S. S., . . . Yein, T. C. J. A. J. o. E. (2020). The extent of covid-19 pandemic socio-economic impact on global poverty. a global integrative multidisciplinary review. 10(4), 213-224.

Cudjoe, G. P., Antwi-Agyei, P., & Gyampoh, B. A. J. C. (2021). The effect of climate variability on maize production in the ejura-sekyedumase municipality, Ghana. 9(10), 145.

Dabija, A., Ciocan, M. E., Chetrariu, A., & Codină, G. G. J. A. S. (2021). Maize and sorghum as raw materials for brewing, a review. 11(7), 3139.

Echendu, A. J. J. S. S. (2022). Flooding, food security and the sustainable development goals in Nigeria: An assemblage and systems thinking approach. 11(2), 59.

Etwire, P. M., Koomson, I., & Martey, E. J. C. C. (2022). Impact of climate change adaptation on farm productivity and household welfare. 170(1), 1-27.

Gaddis, I., Oseni, G., Palacios-Lopez, A., & Pieters, J. (2020). Who Is Employed? Evidence from Sub-Saharan Africa on Redefining Employment.

Kahn, M. E., Mohaddes, K., Ng, R. N., Pesaran, M. H., Raissi, M., & Yang, J.-C. J. E. E. (2021). Long-term macroeconomic effects of climate change: A cross-country analysis. 104, 105624.

Malhi, G. S., Kaur, M., & Kaushik, P. J. S. (2021). Impact of climate change on agriculture and its mitigation strategies: A review. 13(3), 1318.

Nawaz, R., Khan, M. A., Hafiz, I. A., Khan, M. F., & Khalid, A. J. S. R. (2021). Climate variables effect on fruiting pattern of Kinnow mandarin (Citrus nobilis Lour× C. deliciosa Tenora) grown at different agro-climatic regions. 11(1), 1-16.

Obour, P. B., Arthur, I. K., & Owusu, K. J. S. (2022). The 2020 Maize Production Failure in Ghana: A Case Study of Ejura-Sekyedumase Municipality. 14(6), 3514.

Petersson, H., Ellison, D., Appiah Mensah, A., Berndes, G., Egnell, G., Lundblad, M., . . . Wikberg, P. E. J. G. B. (2022). On the role of forests and the forest sector for climate change mitigation in Sweden. 14(7), 793-813.

Prakash, S., & Verma, A. J. I. J. o. B. I., IJBI. (2022). Anthropogenic Activities and Biodiversity Threats. 4(1), 94-103.

Provant, Z., Elderbrock, E., Willingham, A., Carey, M., Antonello, A., Moffat, C., . . . Shahid, S. J. P. R. (2021). Reframing Antarctica's ice loss: impacts of cryospheric change on local human activity. 57.

Wongnaa, C. A., Bakang, J.-E. A., Asiamah, M., Appiah, P., Asibey, J. K. J. W. J. o. S., Technology, & Development, S. (2021). Adoption and compliance with Council for Scientific and Industrial Research recommended maize production practices in Ashanti region, Ghana.

SOCIO-ECONOMIC IMPORTANCE OF HENNA (lawsonia inermis): A REVIEW

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Introduction

Medicinal plants have played an important role in maintaining human health and improving the quality of human society for several years and have served as valuable purposes such as medicine, seasonings, beverages, cosmetics, and dyes (Kamal and Jawaid, 2010). Various plants used for dye extraction are categorized as medicinal. Therefore, multipurpose medicinal plants that have unique sources of various types of chemical compound are being extensively investigated. One such plant is the Henna plant.

Henna, popularly known as Mehndi (in India), has long been used in India and the Middle East countries for coloring palms of hands, soles of feet and fingernails. (Chand et al., 2007).

The ancient African body art technique is in great demand worldwide and the role of henna in this art cannot be underestimated. Despite its importance worldwide, work by Quainoo, Gali and Mahunu (2017) reported it as a neglected plant in Ghana although it serves many purposes prominently in religious and cultural life of Ghanaians particularly the people of northern Ghana. Their investigation focused on the cultivation, processing, and utilization of henna in Savelugu Nantong, a District in the Northern region of Ghana. Their conclusion was that the prospects and utilization of henna has not been given much attention and therefore the need for education and research into its products. Thus, documenting the knowledge of socioeconomic significance of henna is central if the interest of researchers in advancing its utilization prospects and commercial cultivation in plantations is to be stimulated. Hence this review.

Objective of the study

This review seeks to enumerate and document existing literature on the socio-economic importance of henna (Lawsonia inermis L.). The essence is to educate and create awareness on its utilization prospects so as guide and inform further research in developing the plant for commercial plantations.

Methodology

Being a review study, there was no collection and generation of primary data. Information was gathered only by reviewing literature on the phenomenon under study in existing knowledge and publications.

Analysis of Literature

This mainly focused on the distribution, ecology, propagation, botanical description, and socio-economic importance of the Henna plant. However, emphasis in laid on the review of common extracts (products) of henna and their uses in the world.

Socio-economic importance of henna

Several products are extracted from various parts of henna plant, but the most common extracts are the leaf powder or paste and oil extracted from the fruits, leaves and flowers, which are used for cosmetic and medicinal purposes (Semwal et al., 2014).

Henna Tattoo

A henna tattoo is a temporary body art technique that involves drawing designs on the skin using a henna-based ink. To make the ink, henna leaves are crushed into a paste or dried into a powder, then mixed with a liquid such as water, tea, or lemon juice. The artist then pipes or brushes the henna ink onto the skin with a toothpick or stick and leaves it to dry. The drying process gives the henna time to stain the skin. Most people are familiar with India wedding henna tattoos, which are known as mehndi, but henna tattoos are also traditional in places like Egypt, Morocco, Ghana, Nigeria, Pakistan, most North Africa countries, and the Middle East (Kazandjieva et al., 2007).

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In most of these countries' weddings are characterized by henna being painted on the bride to symbolize joy, beauty, spiritual awakening and offering. For Muslim women, the henna is an Islamic alternative to the Western nail polish. In Ghana the business of henna decoration is gradually becoming lucrative for young girls in the Zongo communities. This is because many of the girls use their leisure time to make money by decorating women, especially during festive periods and marriage ceremonies (Muslim Times, 2013).

The use of henna as a natural permanent hair is also a fast-growing trend in the natural hair industry because it is a healthier alternative to the toxic chemical dyes found in the market (Kaniz, 2017).

Henna as a medicinal herb

Despite the fact that henna has primarily been used as dye plant, it is also known for its medicinal properties. The leaves are used in traditional folk medicine in India, as well as many Muslim countries and North Africa (Thordur, 2016). The part of henna shrub used for medicinal purposes are the leaves, seeds, flowers, roots, and stern bark.

Agroforestry Uses (Inter cropping) and ecosystem Services

Due to its dense habit of growth, and amenability to pruning, the plant is particularly useful as a hedge. It is traditionally planted as a windbreak in vineyards (Raj et al., 2014).

Farmers in the northern part of India, plant henna to create living fences and to protect their cultivated fruits and vegetables (Ganvir, 2022). Henna is also planted as a property boundary around their homesteads. With the exception report by Korayem and Osman (1992) who reported farmers intercropping of henna with tomatoes in backyard gardens, there is little or no information on its Agroforestry uses in Ghana despite its role in the in Islamic weddings in most of parts of the country particularly in Northern Ghana.

Conclusion and Recommendations

The review on Lawsonia inermis involves a descriptive and analytic summary of the existing materials relating to the species. By exploring various literature's, it has been revealed that Lawsonia inermis (henna) plant has broad spectrum of pharmacological activities and due to that it can be used as a remedy in herbal medicines. The review reveals a good potential of the plant in Agroforestry system, which can be tapped and expanded, particularly in-home gardens in Northern Ghana. Considering the enormous socioeconomic importance of Lawsonia inermis (Henna) in Northern Ghana and it potential in Agroforestry systems, any effort towards the use of plant in Agroforestry practices in Northern Ghana will be in the right direction. It is therefore recommended that further research be encouraged on its cultivation in the traditional park lands of northern Ghana.

Reference

Ganvir, L. (2022). The Study of Ingenious Knowledge Adopted for Fencing by Farmers and Tribes of Chhattisgarh, India. In Sustainable Engineering, Energy, And the Environment (Pp. 451-464). APPLE Academic Press.

Kazandjieva, J., Grozdev, I., & Tsankov, N. (2007). Temporary henna tattoos. Clinics in dermatology, 25(4), 383-387.

Korayem,A. M., and Osman, H. A. (1992). "Nematicidal potential of the henna plant Lawsonia intermis against the root Knot nematode Meloidogyne incognita". Anzeiger fuer Schaedkingskunde, Pflanzenschutz, Umweltschutz (Germany, FR).

Quainoo, A K; Gali, N M; Mahunu, G K. (2017). HENNA (Lawsonia inermis): A neglected plant in Ghana. Ghana Journal of Horticulture (JHORT), [S.l.], v. 12, n. 1, p. 32-38, feb. 2017.ISSN0855-6350.Availableat: http://www.ghih.org/journal/index.php?journal=ghih&page=article&op=view&path%5B%5D=10>. Date accessed: 06/June /2020.

Rafiq A. Tschannen (2013). Ghana: Muslim Henna. NOVEMBER 25, 2013. The Muslims Times.

Raj, A. J., & Lal, S. B. (2014). Agroforestry theory and practices. Scientific Publishers.

Semwal, R. B., Semwal, D. K., Combrinck, S., Cartwright-Jones, C., & Viljoen, A. (2014). Lawsonia inermis L.(henna): Ethnobotanical, phytochemical, and pharmacological aspects. Journal of Ethnopharmacology, 155(1), 80-103.

Sourced at https://themuslimtimes.info/2013/11/25/ghana-muslim-henna/

Thordur Sturluson. The herbal resources. https://www.herbal-supplement-resource.com.

Unknown Author, 2015. Lawsonia Inermis. www.globinmed.com

THE ROLE OF FOREST IN COMBATING CLIMATE CHANGE: A REVIEW

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Introduction

The expanding human population and activities have caused changes in the Earth's environment, the most notable of which is an increase in carbon dioxide and other greenhouse gas concentrations in the troposphere. Over the lengthy time scales of glacial and interglacial periods, there is significant evidence of changes in the composition of greenhouse gases in the lower atmosphere throughout the previous century (Lacis et al, 2010).

According to National Geographic, (2019), the forest currently covers over 30% of the world's landscape. Man's actions have resulted in a loss of vegetation cover all across the globe. The World Wildlife Fund also reported that, the earth loses 18.7 million acres of forest per year, or 27 soccer fields per minute (WWF, 2018). If the adage that when the last tree dies the last man dies is anything to go by, then advancing the understanding of the nexus between afforestation and climate change mitigation and ecosystem resilience is a step in the right direction. That is what the review sought to achieve.

Climate change

Climate change is the most pressing global environmental and development issue confronting the world today (Arndt and Tarp, 2017). It is defined as the average weather in a specific location/area, which includes factors such as temperature, precipitation, humidity, and windiness (Jackson, 2021). Climate change is one of our generation's defining issues.

Causes of climate change

Climate change is a broad range of global phenomena caused primarily by the combustion of fossil fuels, which emits heat-trapping gases into the atmosphere (NASA, 2020). Scientists have classified climate change causes into two broad categories: natural and human causes (Crowley, 2000). The former is the natural phenomenon whilst the latter is said to be caused by human activities.

Natural causes of climate change

- The oceans, or ocean currents. The oceans play an important role in determining CO2 concentrations in the atmosphere. Changes in ocean circulation may have an impact on climate by causing CO2 to enter or exit the atmosphere (Hoffman et al, 2010)
- Volcanic eruptions: Volcanoes spew out tiny particles known as aerosols. They have a cooling effect on the earth's surface because they reflect solar energy into space (Ammann et al, 2010).
- The Earth's orbital changes: Changes in the earth's tilt can

cause minor but climatically significant changes in the strength of the balance as a function of temperature over a decade. Contribution of clouds: Global satellite analysis supported by climate models revealed that cloud cover exacerbates warming because, as the earth's average temperature rises, clouds will accelerate global warming by trapping more heat (Perkins, 2010).

Human causes of climate change

- Emissions into the atmosphere from automobiles, airplanes, and trains. Carbon dioxide remains in the atmosphere longer than other gases, so vehicles have a more harmful impact on climate change in the long term (Reynard, 2017).
- Greenhouse gases emitted by home appliances in your home, use electricity that causes greenhouse gas emissions. For instance, the air conditioner also contains refrigerants that, if allowed to escape into the atmosphere, contribute heavily to global warming and may additionally deplete the ozone layer, depending on the age of the unit (Rachel, 2021). Also, greenhouse gases emitted by the burning of fossil fuels releases carbon dioxide into the atmosphere.
- Greenhouse gases emitted by gas flaring in oil fields. The burning of unwanted gas associated with oil production called "flaring" remains the most carbon-intensive part of producing oil, reducing oil flaring could cut emissions into the atmosphere in a big way (Stanford, 2018). So, are greenhouse gases released into the atmosphere by industries?
- Agriculture through clearing forests for fields, burning crop residues, submerging land in rice paddies, raising large herds of cattle and other ruminants, and applying nitrogen fertilizer all emit greenhouse gases into the atmosphere which contribute global warming (Rosenzweig and Hillel, 1995).

Effects of climate change on the environment

The effect of climate change on flora

Only Earth has signs of life, and plants are regarded as key organisms in the formation of life on Earth (Berg et al, 2017). The energy produced by plants through photosynthesis is the driving force behind life on Earth (Alnsour et al, 2015). Climate, more than any other factor, influences the large-scale distributions of plant species and vegetation in general. Rapid climate change, exacerbated by rising greenhouse gas emissions (IPCC, 2007), has an impact on current and future vegetation patterns. Climate change has created a global food security threat, which is one of the most pressing challenges of the twenty-first century.

The effect of climate change on fauna

There is already undeniable evidence that climate change and global warming are affecting the distribution and behavior of animals, birds, and plants (Mohammadi, 2019). With climate change, many species have lost native habitats, geo-climatic associations, and physiologically optimal environmental conditions and have made many species extremely vulnerable to extinction.

The role of forests in climate change mitigation

The United Nations Food and Agriculture Organization (FAO, 2000) defined forest as having more than 10% tree crown cover (or equivalent stocking level) and an area greater than 0.5 ha. According to studies (Federici et al, 2017), the global mitigation goals such as reducing deforestation and forest degradation and improving forest management (IFM) cannot be met unless forests are consciously included in such goals. Forests play the following roles in mitigating climate change:

a. **Absorption of greenhouse gases by trees**
   The ability of the world's forests to absorb atmospheric carbon makes them into large carbon stocks. Forests, mainly tree trunks, twigs, and leaves contain 80% of terrestrial and 40% of the underground (including tree roots) bound Carbon. Their total carbon content is estimated from 352-532PgC to 987-990PgC.7 (Liiv et al, 2020). (PgC: petagrams of carbon or 1015 grams of carbon; 1 PgC is equal to 1 Gigatonne of carbon).
b. **Regulation of air quality**
   One potential benefit of urban green space has been highlighted as the role of vegetation in mitigating the effects of air pollution. Vegetation intercepts particulate matter (PM10) in the air, lowering concentrations and thus improving air quality.
c. **Precipitation (moisture) regulation**
   Forests have a strong influence on the availability and, especially, the quality of water. Forested catchments protect the high-value surface and drinking water (Carina, 2008). The absorption and creation of rainfall, as well as the exchange of atmospheric gases, allow forests to regulate local and global weather (Spracklen et al, 2018).
d. **Regulation of atmospheric temperature**
   Trees play an especially important role in regulating temperature. The amount of heat energy absorbed, stored, and transferred, as well as the use of

cooling strategies, can all be used to effectively modify the urban climate.

Conclusion and recommendations

Per the findings from the review, we recommend that Government take a keen interest in forest research towards establishment of forests and management strategies for conservation and environmental protection.

References

Alnsour, M., Ludwig- Müller, J. (2015). "Potential effects of climate change on plant primary and secondary metabolism and its influence on plant ecological interactions". In Journal of Endocytobiosis and Cell Research, 26:90-99.

Ammann, C. M., Washington, W. M., Meehl, G. A., Buja, L. and Teng, H., (2010). Climate engineering through artificial enhancement of natural forcings: Magnitudes and implied consequences. J. Geophys. Res. 115, D22109.

Arndt, C., & Tarp, F. (2017). Aid, environment, and climate change. Review of Development Economics, 21(2), 285-303.

Berg, G., Köberl, M., Rybakova, D., Müller, H., Grosch, R., & Smalla, K. (2017). Plant microbial diversity is suggested as the key to future biocontrol and health trends. FEMS microbiology ecology, 93(5).

Carina S. (2008). Influence of Forest Management on Water Quality. Accessed 24 July 2014 from www.waldwissen.net/wald/naturschutz/gewaesser/fva_wasserhandbuch_einfluss/index.

Federici, S., Lee,D.and Herold, M. (2017). Forest Mitigation: A Permanent Contribution to the Paris Agreement? (Working Paper) http://www.climateandlandusealliance.org/wp-content/uploads/2017/10/Forest_Mitigation_A_Permanent_Contribution_to_Paris_Agreement.pdf. Accessed 29 July 2021

Food and agriculture organization (FAO). (2020). The state of the world's forest. http://www.fao.org/3/ca8642en/ca8642en.pdf. Accessed 20 August 2021.

Hillel, D. (1995). Potential impacts of climate change on agriculture and food supply. Consequences 1 (2), 1-25.

Hingant, B., & Albe, V. (2010). Nanosciences and nanotechnologies learning and teaching in secondary education: A review of the literature. Studies in Science Education, 46(2), 121-152.

Hoffman, A. J. (2010). Climate change as cultural and behavioral issue: Addessing barriers and implementing solutions. Organization Dynamic, 39(4), 295-305.

IPCC, C. W. T. (2007). Climate change 2007: synthesis report. Geneva, Switzerland: IPCC.

Jackson, S. T. (2021). Transformational ecology and climate change. Science, 373(6559), 1085-1086.

Lacis, A. A., Schmidt, G. A., Rind, D., & Ruedy, R. A. (2010). Atmospheric CO2: Principal control knob governing Earth's temperature. Science, 330(6002), 356-359.

Liiv, J., Zekker, I., Tamm, K., & Rikmann, E. (2020). Greenhouse gases emission and climate change are beyond the mainstream. MOJ Biorg Org Chem, 4(1), 11-16.

Mohammadi, S., Ebrahimi, E., Moghadam, M. S., & Bosso, L. (2019). Modelling current and future potential distributions of two desert jerboas under climate change in Iran. Ecological Informatics, 52, 7-13.

National Aeronautics and Space Administration NASA. (2020). Climate Change: Meaning, Definition, Causes, Examples, and Consequences. Youmatter/Definitions, https://youmatter.world/en/definition/climate-change-meaning-definition-causes-and-consequences/. Accessed 29 July 2021.

Perkins, S. (2010). Complex effects. Nature Climate Change, 1-1.

Reynard, N. S., Kay, A. L., Anderson, M., Donovan, B., & Duckworth, C. (2017). The evolution of climate change guidance for fluvial flood risk management in England. Progress in physical Geography, 41(2), 222-237.

Spracklen, D. V., Baker, J. C. A., Garcia-Carreras, L., & Marsham, J. H. (2018). The effects of tropical vegetation on rainfall. Annual Review of Environment and Resources, 43, 193-218.

World Wildlife Fund WWF. (2020). Responsible forestry. https://www.worldwildlife.org/industries/responsible-forestry. Accessed 20 August 2021

FOODS OF THE FUTURE: DAIRY ALTERNATIVES —YOGHURT MADE FROM PLANT-BASED MILKS.

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Figure 1: Yoghurt made from plant-based minks: (a) coconut milk, (b) oat milk and (c) soy milk.

For centuries, milk from animals has been the primary source of dairy products such as cheese, butter, yoghurt, ghee etc. However, several technological advances in the food industry have seen an increase in the production of dairy alternatives and their products, which not only mimic the nutritional properties of dairy products from bovine sources, but their organoleptic properties as well.

Many plant sources such as cereals and pseudocereals, nuts and legumes have proven to be viable sources of 'milk'. These plant-based alternatives are suitable substitutes for consumers with lactose intolerance (the inability to breakdown lactose due a lack of the lactase enzyme in the digestive tract), consumers with milk allergies or those seeking a healthier lifestyle change. Although some might argue that plant-based milk alternatives lack some of the essential nutrients needed for proper growth and development, researchers have developed methods of safely enriching and fortifying these alternatives by blending and combining with other nutrient rich plant sources.

The production of conventional yoghurt from animal-sourced milk is by the controlled fermentation of the milk using select lactic acid bacteria (LAB). The introduction of Lactobacillus bulgaricus and Streptococcus thermophilus in a 1:1 ratio starts the entire fermentation process at 43°C. The bacteria metabolize the lactose present and releases lactic acid as a by-product. An increase in lactic acid content leads to a reduction in pH which causes the milk proteins to denature and curdle; this is how the characteristic texture of yoghurt is obtained.

In our plant-based alternatives however, the predominant sugars are α-galactosides such as raffinose and stachyose instead of the milk sugar, lactose. These sugars can only be broken down by the α-galactosidase enzyme; this hinders digestion and assimilation of the product (Hati et al., 2014). To enhance ease of digestibility of plant-based yoghurts, lactic acid bacteria strains which show α-galactosidase activity are introduced into the plant-based milks to convert the sugars into lactic acid to begin the fermentation process. Manufacturers also rely on acidity regulators to decrease and control the pH of the milk and thickeners to achieve the desired texture in the final product.

The bacteria strains commonly used in plant-based yoghurts are Streptococcus thermophilus, Lactobacillus delbrueckii subsp. bulgaricus, Lactobacillus acidophilus and Bifidus lactis; however, new strains of lactic acid bacteria are being research and tested for viability (Dusabe et al., 2021; Harper et al., 2022)

The biggest challenge in the production of plant-based yoghurt is mimicking the texture of dairy yoghurt; the hydrophobic structures of plant proteins make them less susceptible to proteolysis and denaturation (Sim et al., 2021). Food technologists used to rely on thickeners to improve the gelling properties in order to achieve the characteristic consistency of yoghurt. Now, in light of information from

research studies, the plant-based alternative sector is utilizing exopolysaccharide-producing LAB strains. Exopolysaccharides are long chain polymers of sugars and carbohydrates which act as hydrocolloids when introduced into a liquid medium. The exopolysaccharides produced by the bacteria increases the viscosity and the water holding capacity of the plant-based alternative by interacting with the proteins and micelles present in the plant-based milk and forming a relatively strong exopolysaccharide-protein network. This interaction improves the texture of the plant-based yoghurt and makes it similar to that of dairy yoghurt.

Research done by Hickisch, also shows that the processing techniques used during production of the alternative milk ,such as High Pressure Homogenization (HPH) to achieve uniform particle size and Ultra High Temperature (UHT) Processing have an effect on its gel formation and exopolysaccharide concentration which ultimately affects the textural qualities of the final product (Hickisch et al., 2016b; Sim et al., 2020).

The bioavailability of nutrients in plant-based yoghurt might be restricted by the presence of anti-nutritional compounds or factors such as phytic acid, condensed tannins, alkaloids, and lectins in high concentrations. These compounds are abundant in plant matrices, and they lower the nutritional value of the final product.

During fermentation, the decrease in pH caused by an increase in lactic acid activates phytase or phosphatase which degrades phytic acid and other anti-nutritional compounds. Trypsin inhibitors are inactivated through thermal treatments and condensed tannins can be broken down through LAB activity (Montemurro et al., 2021).

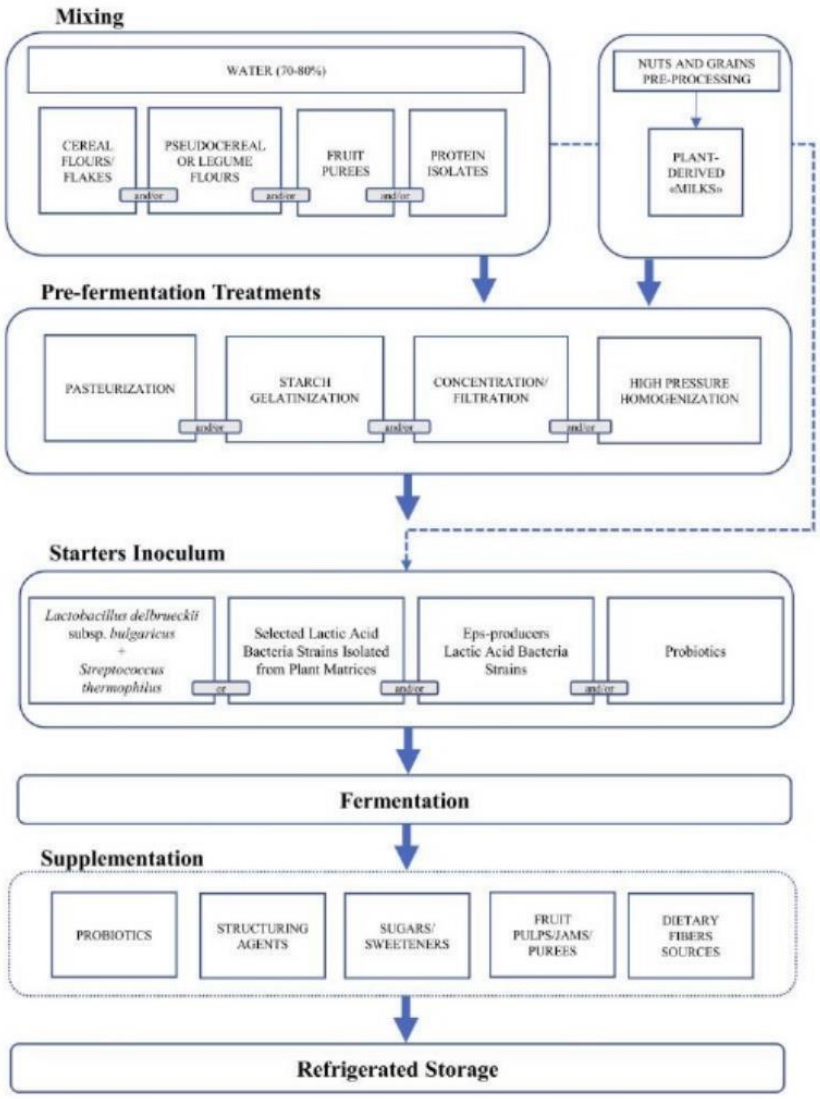

Figure 2: Flowchart of Plant-based Yoghurt Production

Most alternatives to traditional foods are intended to be healthier meal options and plant-based yoghurts are no exception. Most manufacturers produce these alternatives with little or no sugar but may introduce fruits, sweetened nuts or artificial sweeteners as flavor enhancers.

The intended shelf-life of plant-based yoghurts is similar to dairy yoghurt; 2-6 weeks after opening but can last up to 6 months unopened. Under optimal refrigeration conditions, the sensory and textural properties can be preserved and undesirable changes such as aqueous phase separation, loss of viscosity, appearance of off odors, and overall intensification of acidic smell and flavor can be avoided (Montemurro et al., 2021).

Plant based milks and their fermented derivatives are good sources of probiotics and can be considered as key elements in sustaining food security for the growing global population. Researching and developing effective ways of utilizing our abundant plant sources of food would not only ensure that the nutritional needs of the growing global community are met but would result in a decline in greenhouse-gas emissions and other harmful environmental concerns.

References

Baskar N, Varadharajan S, Rameshbabu M, Ayyasamy S, Velusamy S. Development of plant-based yogurt. Foods and Raw Materials. 2022;10(2):274–282. https://doi.org/10.21603/2308-4057-2022-2-537

Bernat, N., Chafera, M., Chiralt, A., and Gonzalez-Martınez, C. (2015) Probiotic fermented almond "milk" as an alternative to cow-milk yoghurt. Int J Food Stud 4: 201–211.

Dusabe A, Chacha M, Vianney J. M, Raymond J. Development of Plant-Based Yoghurt Rich in Bioavailable Essential Nutrients and Bioactive Compounds from Ingredients Available in East Africa. Curr Res Nutr Food Sci 2021; 10(1).

Harper AR, Dobson RCJ, Morris VK, Moggré GJ. Fermentation of plant-based dairy alternatives by lactic acid bacteria. Micro Biotechnology. 2022 May;15(5):1404-1421. Doi: 10.1111/1751-7915.14008.

Hati, S., Vij, S., Mandal, S., Malik, R.K., Kumari, V., and Khetra, Y. (2014) α-Galactosidase activity and oligosaccharides utilization by Lactobacilli during fermentation of soy milk. J Food Process Preserv 38: 1065–1071.

Hickisch, A., Beer, R., Vogel, R.F., and Toelstede, S. (2016a) Influence of lupin-based milk alternative heat treatment and exopolysaccharide-producing lactic acid bacteria on the physical characteristics of lupin-based yogurt alternatives. Food Res Int 84: 180–188

Montemurro, Marco, Erica Pontonio, Rossana Coda, and Carlo Giuseppe Rizzello. 2021. "Plant-Based Alternatives to Yogurt: State-of-the-Art and Perspectives of New Biotechnological Challenges" Foods 10, no. 2: 316. https://doi.org/10.3390/foods10020316

Sim S.Y.J., Srv, A., Chiang, J.H., and Henry, C.J. (2021) Plant proteins for future foods: a roadmap. Foods 10: 1967.

FOOD FOR ASTRONAUT: AN AKOKONO (Palm weevil larvae) GRANOLA BAR

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Introduction

Food is defined as anything solid or liquid which is taken into the body to regulate certain processes which includes growth and repairing worn out tissues. Just as we wake up, have breakfast, and begin our day, so do astronauts. When they are out in their specified space stations, astronauts need food to survive.

Space food is a type of food product created and processed for consumption by astronauts during missions to outer space. Unlike us on earth, food is a very complex topic when it comes to space travel as food taken into space must be lightweight, compact, tasty and nutritious. They must also have longer shelf-life without refrigeration. Some ways of storing space food are through irradiation, freeze drying and thermo stabilization.

Example of a space food

The Akokono (Palm weevil larvae) Granola Bar

Astronauts require calcium rich food due to the weightlessness in space (Jun Iwamoto, 2005). Palm weevil larvae are rich in calcium, essential amino acids, vitamins, and minerals, making them an ideal food alternative for astronauts. Palm weevil granular bar is a nutritious food that is made from palm weevil larvae. The larvae are boiled, dried, and then mixed with other ingredients to form a bar. The granular was made from oats, seeds, butter, honey and palm weevil larvae. Overall, the key techniques involved in making palm weevil granular bars are boiling and drying the larvae, grinding them into a fine powder, mixing the powder with other ingredients, forming the mixture into bars, and storing the bars in a cool, dry place.

Palm weevil (akokono) larvae

A preliminary review towards the ideal components for Palm weevil granola bar space food

Palm weevil larvae are a common delicacy in many parts of the world, and they are a rich source of protein and other nutrients. However, it may be challenging to consume palm weevil larvae in their natural form, especially in space, where the food should be compact, easy to store, and have a long shelf-life. Granular bars are one way to overcome these challenges. To create the ideal components for palm weevil granular bar space food, several factors need to be considered, including taste, texture, nutrient content, and shelf-life.

Here are some components that could be included:

Palm weevil larvae: Serves as the primary ingredient in the granular bar. The larvae could be dehydrated and ground into a fine powder to make it easier to incorporate into the granular bar.

Protein-rich ingredients: Other protein-rich ingredients could be added to enhance the nutritional value of the granular bar. Examples include soy protein isolate, pea protein, or whey protein.

Carbohydrates: Essential for energy, and they could be included in the granular bar in the form of oats, rice, or quinoa.

Fats: Necessary for the body to absorb certain nutrients and to provide energy. Sources of healthy fats could include nuts, seeds, or coconut oil.

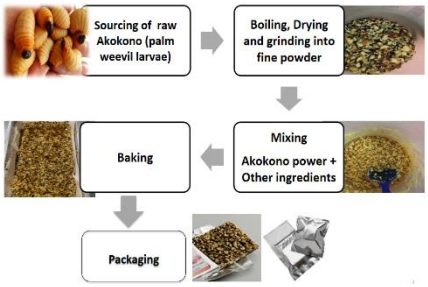
Flavorings: Could be added to the granular bar to improve the taste. Spices such as garlic, onion, or chili powder could be used to add flavor and enhance the taste of the palm weevil larvae.

Shelf-life extenders: To ensure a long shelf-life, preservatives such as salt, citric acid, or ascorbic acid could be added.

Binding agents: To hold the granular bar together, binding agents such as honey, agave nectar, or molasses could be used.

Vitamins and minerals: To ensure the granular bar provides a complete nutritional profile, vitamins and minerals could be added. Examples include vitamin D, iron, or calcium.

Making the akokono granular bar



Flow chart for the development of the Akokono Granola Bar

In conclusion, creating an ideal component for palm weevil granular bar space food would require careful consideration of taste, texture, nutrient content, and shelf-life. By incorporating the right ingredients, a granular bar could be created that provides a complete nutritional profile and that tastes good as well.

The best packaging for Palm weevil granola bar space food

When it comes to packaging food for space travel, there are several factors to consider, such as weight, durability, and the ability to preserve the food's nutritional value and flavor.

Here are some packaging options to consider for Palm weevil granular bar space food.

Vacuum-sealed pouches: Vacuum-sealed pouches are commonly used for space food as they are lightweight, airtight, and can preserve the food's nutritional value and flavor for long periods. They can also be easily disposed of after use.

Flexible foil packaging: Flexible foil packaging is also a popular option for space food. It is lightweight, durable, and can protect the food from oxygen and moisture.

Rigid plastic containers: Rigid plastic containers can be used for space food that needs extra protection. They can withstand high pressure and impact, and they are reusable.

Metal cans: Metal cans can also be used for space food, but they are heavier than other options. However, they can provide extra protection against radiation and impacts.

Ultimately, the best packaging for Palm weevil granular bar space food will depend on the specific requirements of the space mission and the preferences of the astronauts. It is essential to consider factors such as weight, durability, and food preservation when choosing packaging options for space food.

Food Supplement Powder

In addition to palm weevil larvae granola bars, astronauts require a food supplement powder to ensure they are receiving all the necessary vitamins and minerals for their health. The food supplement powder is a combination of vitamins, minerals, and other essential nutrients that are required for a balanced diet.

The food supplement powder is packaged in airtight pouches and can be mixed with water to create a nutrient-rich drink. The powder contains all the necessary vitamins and minerals required for a balanced diet, including vitamin A, vitamin C, vitamin D, vitamin E, vitamin K, thiamin, riboflavin, niacin, vitamin B6, folate, vitamin B12, calcium, iron, magnesium, potassium, and zinc.

Food supplement powders are an important addition to the astronaut's diet as they provide a convenient and easy way to consume all the necessary nutrients. The

powder is lightweight and has a long shelf-life, making it ideal for space travel.

Contribution of Innovation to SDG

Our products, Akokono granola bar and food supplement powder, are linked to the SDG number 2 (zero hunger) and number 3 (good health and wellbeing).

SDG 2: Zero hunger is achieved by providing nutritious and affordable food which is accessible for all class of people (astronauts) at all times (food security). Akokono granola bar and food supplement powder are rich in the various types of nutrients especially calcium which is needed by astronauts making it a nutritious yet affordable food option.

SDG 3: our food products are nutrient-dense making them balanced diets for astronauts.

This will ensure the normal growth and wellbeing of astronauts.

Conclusion

Akokono granola bar is a nutritious that is made from palm weevil-larvae which is a rich source of proteins and other nutrients. However, it may be challenging to eat palm weevil larvae in their raw form, especially in outer space. Granular bars are one way to overcome these challenges. The Akokono granular bar contains; palm weevil larvae, protein rich ingredients (E.g.: soy protein, pea protein), carbohydrates (oats, rice, or quinoa), fats, flavorings, shelf-life extenders, binding agents, vitamins and minerals.

Palm weevil larvae granola bars and a food supplement powder provide a nutritious and balanced diet for astronauts while considering convenience and cost. Palm weevil larvae granola bars are a sustainable and high-protein food source that can be harvested in space, while the food supplement powder provides all the necessary vitamins and minerals required for a balanced diet. These two food items are lightweight, easy-to-prepare, and have a long shelf-life, making them ideal for space travel. In addition to palm weevil larvae granola bars, astronauts require a food supplement powder to ensure they are receiving all the necessary vitamins and minerals for their health. The food supplement powder is a combination of vitamins, minerals, and other essential nutrients that are required for a balanced diet.

References

Adeline W, (,2021), "How Do Astronauts Eat In Space?", USA, The Payload Blog, Page 1-2, http://www.kennedyspace-center.com/blog/food-in-space

Kumar, L., & Gaikwad, K. K. (2023). Advanced food packaging systems for space exploration missions. Life Sciences in Space Research, 37, 7-14. https://doi.org/10.1016/j.lssr.2023.01.005

Pandith, J. A., Neekhra, S., Ahmad, S., & Sheikh, R. A. (2023). Recent developments in space food for exploration missions: A review. Life Sciences in Space Research, 36, 123-134. https://doi.org/10.1016/j.lssr.2022.09.007

Watkins, P., Hughes, J., Gamage, T. V., Knoerzer, K., Ferlazzo, M. L., & Banati, R. B. (2022). Long term food stability for extended space missions: A review. Life Sciences in Space Research, 32, 79-95. https://doi.org/10.1016/j.lssr.2021.12.003

RICE FLOUR AS A REPLACEMENT FOR WHEAT FLOUR: A POSSIBILITY?

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Introduction

Flour is a fine powder made by grinding grains, roots, or nuts. It is a fundamental ingredient in many baked goods such as bread, cakes, cookies, and pastries. Flour is also used as a thickener in sauces and gravies. The most used flour is wheat flour, but other types of flour such as corn flour, rice flour, and potato flour are also available. (Azudin, 2006). It is composed of different nutrients which makes it healthy for human consumption. Different types of flour have different gluten content, which affects the texture and rise of baked goods. Flour has been a staple food for thousands of years and continues to be a vital ingredient in many cuisines worldwide. Finding an alternative to wheat flour will help achieve the Sustainable Development Goal one (no poverty) and two (zero hunger).

Whether it's the light and fluffy texture of a cake, the chewiness of a loaf of bread, or the delicate flakiness of a pie crust, flour plays a crucial role in achieving the desired results in baking and cooking. The process of transforming grains into flour is a fascinating journey that combines ancient traditions with modern techniques. Today, flour production has become an industrialized process that involves advanced machinery and technologies. Wheat is the most widely cultivated and commonly used grain for flour due to its gluten content, which contributes to the elasticity and structure of baked goods. Flour comes in different varieties, classified based on the parts of the grain used and the level of processing. texture and longer shelf life but with reduced nutritional content. The modern era coupled with the diverse dietary preferences and restrictions, alternative flours that has economic value and help ensure food security.

Flour is composed of proteins, starch, lipids, sugars, and enzymes. However, the most important are the; Proteins = (10-12) %; Starch = (70-75) %; Sugar = (2-3) %; Lipids =2% Regarding physio-chemical properties we have: colour, moisture, protein, starch, minerals, phytate, free phenolic compounds, etc. These percentages are for every 100g of flour. (Goesaert, 2005). Flour is a good source of protein (repairing worn-out tissues), rich in calcium for strong bones and teeth, rich in fibre to prevent constipation and presence of choline which is good for the liver.

Objective

This project focused on finding an alternative to wheat flour (rice flour) in developing rice cake.

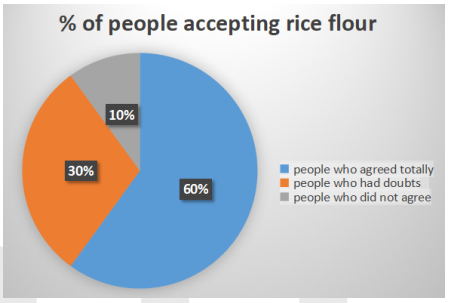
Why Rice Flour

Rice flour is a type of flour that is made from finely milled rice grains. It can be made from either white or brown rice, with brown rice flour being more nutritious due to its higher fiber content and greater

concentration of vitamins and minerals. Rice flour is a good source of carbohydrates and provides energy to the body. It is also low in fat and cholesterol and contains essential amino acids. Due to its gluten-free nature, rice flour is suitable for those with gluten intolerance or celiac disease. It is also a popular ingredient in vegan and vegetarian cooking. In recent years, rice flour has gained popularity in the global food industry as a gluten-free alternative to wheat flour. It is widely used in the production of gluten-free baked goods, snacks, and ready-to-eat meals. Its versatility and easy availability have made it a preferred choice for many food manufacturers, home cooks, and consumers looking for gluten-free alternatives. Overall, rice flour is a versatile and nutritious ingredient that has a wide range of culinary applications. Its gluten-free nature, low fat content, and essential nutrient profile make it a healthy and popular alternative to wheat flour and perhaps better than wheat flour.

Survey on Consumer Preference for Rice Flour

A short survey was done on which flour is the best in the market. Almost all the interviewees chose wheat flour because it is the most common and widely used in Ghana. It was certain that they all liked the wheat flour, but they were all complaining about one thing; the price of wheat flour being expensive nowadays. As such, another survey was done asking respondents whether they will accept rice flour in replacing wheat flour and surprisingly a lot of people agreed to it.



Survey results on consumer acceptance of rice flour

The survey showed that majority agreed to the rice flour idea and were willing to purchase products made from rice flour and were also willing to convince other people to purchase and consume rice flour. Those who were doubting just wanted more information concerning rice flour. Even though they agreed to buying products made of rice flour, they were not certain that it will be as good as wheat flour products.

Those who did not agree to this at all were of the view that wheat was the best of all the cereal grains suitable for making flour and all other grains could not be compared in terms of taste, texture, etc.

The Processing Steps for the rice flour

The processing of the rice flour involved several steps, starting from the cleaning and conditioning of the grains to the final milling and packaging of the flour.

The following are the common steps involved in flour processing:

Cleaning: The grains are first cleaned to remove any foreign materials such as stones, dirt, and debris. This is done using a combination of sieving, aspiration, and magnetic separation.

Conditioning: In this step, the grains are moistened to improve their milling quality. This helps to soften the bran and germ, making it easier to remove during the milling process. Conditioning also helps to improve the gluten quality in wheat flour.

Milling: The milling process involves crushing and grinding the grains into flour. The type of mill used depends on the type of grain and the desired quality of flour. There are various milling methods, including stone milling, roller milling, and impact milling.

Sifting: The flour is sifted through a series of sieves to remove any remaining bran, germ, and other impurities. This helps to produce a finer, more refined flour.

Bleaching: Some flours, particularly wheat flour, undergo bleaching to improve their color and baking properties. This is done using chemical agents such as chlorine or benzoyl peroxide.

Fortification: In many countries, flour is fortified with vitamins and minerals such as iron, folic acid, and niacin to address nutrient deficiencies in the population.

Packaging: The flour is then packaged in bags, distributed, and used in product development.

Cake Developed from Rice Flour

Cake developed from rice based flour.

Sensory evaluation sensory on the developed rice cake

Conclusion

Rice flour stand at a very good position to be used as an alternative flour for wheat. The developed cake from rice is a proof that it is possible. The conducted survey shows that more education on Rice flour should be enhanced to sensitize consumers. Need to innovate and accept new food products. The decision to use rice flour as a replacement for wheat flour may be dependent on the specific applica-

tion, availability, and desired quality and texture of the final product which can be explored in further studies.

References

Balba., M.E., Eshov., M.,Ismailova., N. The Impacts of Russian- Ukrainian WAR ON The Global Economy. Advance Online Publication. DOI:2022;10

Nasir M.A., Nugrobo A.D, Lakner Z. Impact of the Russian-Ukrainian Conflict in Global Food Crops. Foods. 2022 Sept 23;11(19)

Azudin., N. The military process. Kansas City, MO; Sosland Publishing CO:(2006)

Sobrova, P, Adam V, Vasatkova, A.Beklova .M. Zeman L, Kizek R. Interdisciplinary Toxicology.(2010); 94-99.

BEYOND THE LABEL: THE TRUTH ABOUT FOOD ADDITIVES AND THEIR IMPACT ON HEALTH

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Introduction

Behind the delectable allure of modern cuisine lies a hidden story of food additives making them an indispensable part of our modern culinary landscape. These intriguing compounds, carefully selected by food manufacturers, thread their way into our daily meals, transforming ordinary dishes into exceptional delights. The European Union legislation defines them as "any substance not normally consumed as a food in itself and not normally used as a characteristic ingredient of food, whether or not it has nutritive value". Today, more than 2500 additives are intentionally added to food to keep certain properties or to extend shelf-life, while many others were banned throughout the years, some of them at a global level and others only in specific countries (Barreiro et al., 2014). Human exposure to food additives is evaluated by the acceptable daily intake (ADI) and estimated daily intake (EDI). ADI is the federal standard for maximum allowable dietary exposure to a food additive. (Lim et al., 2019). Globally, the 2 major regulators of food additives are the European Food Safety Authority (EFSA) and the Food and Drug Administration (FDA) of the United States of America.

In the middle of the 20th century, processed food became an important part of human nutrition, and legal chemical additives became increasingly prevalent in them, fostering tight regulation, which remains controversial due to the high number of studies concerning food additives that produce conflicting results and different interpretations by governments (Fennema, 2014). Within the context of EU, some functional classes of food additives are sweeteners, preservatives, flavor enhancers, Emulsifiers, and stabilizers.

- **Preservatives**

  This group is composed of antimicrobials, antioxidants, and antibrowning agents.

  The E numbers of the preservatives range from E200 to E399 (Fennema, 2014)

  Antimicrobials: The antimicrobials are added to food for 2 purposes, a) to control natural spoilage of food (food control) and/or b) to avoid/control contamination by microorganisms, including pathogenic ones (of food safety concern) (Tajkarimi et al., 2010).

  Antioxidants: Antioxidants, which belong to another category of preservatives, play a crucial role in prolonging the shelf life of numerous food products. Antioxidants prevent the oxidation of molecules by donating a hydrogen atom or an electron, becoming themselves reduced, in the radical form, but contrary to other radicals, antioxidants when in radical form are stable and do not allow further reactions to take place, therefore preserving the status quo of the system (Carocho and Ferreira, 2013a).

  Antibrowning agents: Antibrowning agents are commonly used as food additives to help counter food browning, which can occur at any moment during handling, processing, and storage.

- **Flavor enhancers**

  Additives like monosodium glutamate (MSG) and ribonucleotides are substances that boost

and augment the flavor of food. Their purpose is to activate certain taste receptors in our mouths, leading to an enhanced sensory perception. Despite common misconceptions, flavor enhancers are typically harmless and pose no significant health risks when consumed in reasonable amounts.

- **Sweeteners:**
  Sweeteners, both natural and artificial, are used to impart a sweet taste without the calories associated with sugar. Notable sweeteners include aspartame, saccharin, and stevia. Despite undergoing thorough safety assessments, approved sweeteners have raised concerns regarding potential health effects, such as their association with cancer or metabolic disorders. Nevertheless, the current body of scientific evidence does not substantiate these allegations.
- **Emulsifiers and Stabilizers**
  Emulsifiers and stabilizers are ingredients incorporated into food items to maintain their texture, consistency, and visual presentation. Some instances of these additives include lecithin, xanthan gum, and carrageenan. While they are typically regarded as safe, a limited number of studies suggest that certain emulsifiers and stabilizers may disrupt the equilibrium of gut microorganisms, potentially influencing digestion, and overall gastrointestinal well-being.

Potential Health Effects

Despite the crucial roles food additives play in the modern food industry by providing convenience and improving the overall quality of our food, there is an ongoing debate about the safety and potential health effects of certain food additives.

Below are some potential adverse health concerns about extended use of food additives.

- **Allergic Reactions:**
  Some individuals may be prone to experiencing an allergic reaction to certain food additives. They, however, experience symptoms such as hives, itching, swelling, or difficulty breathing. Common allergens include preservatives, color additives, and flavor enhancers. It is advisable to identify the specific additve which may pose a suspected allergy, and as much as possible, avoid its consumption.
- **Hyperactivity and Behavioral Changes:**
  Over the years, many studies have suggested a possible link between certain food additives, specifically artificial colorings and preservatives, and hyperactivity or behavioral changes in children. These children tend to be overly active and exhibit contrary behavioral traits. However, more research is needed to establish a definitive connection, and individual sensitivities may play a role.
- **Carcinogenicity:**
  There have been raised concerns regarding the possible cancer-causing properties of some food additives like artificial sweeteners such as aspartame. Nevertheless, thorough investigations and regulatory organizations like the FDA and EFSA have consistently determined that authorized food additives are safe for consumption if they are within the recommended limits.

Conclusion

Food additives have revolutionalized the appearance, nutritional components, and overall palatability of foods. It is also crucial to approach their usage with caution due to potential health concerns. It is recommended that consumers need to be aware of these concerns and advocate for stricter regulations to ensure the responsible and safe use of additives in the food industry.

References

Carocho, M., Barreiro, M.F., Morales, P. and Ferreira, I.C., 2014. Adding molecules to food, pros, and cons: A review on synthetic and natural food additives. Comprehensive reviews in food science and food safety, 13(4), pp.377-399.

Carocho, M. and Ferreira, I.C., 2013. A review on antioxidants, prooxidants and related controversy: Natural and synthetic compounds, screening and analysis methodologies and future perspectives. Food and chemical toxicology, 51, pp.15-25.

Tajkarimi, M.M., Ibrahim, S.A. and Cliver, D.O., 2010. Antimicrobial herb and spice compounds in food. Food control, 21(9), pp.1199-1218.

Lim HS, Kim M, Lee G, Shin JW. Dietary exposure assessment of synthetic food colours using analytical concentrations in Korea. Food Additives & Contaminants: Part A. 2019 Oct 3;36(10):1453-66.

A GRASP OF THE GLYCEMIC INDEX

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What is glycemic index?

The term "glycemic index" sounds convoluted, but it is simply a measure of the rise in blood sugar after eating a food that contains carbohydrates. A food's glycemic index is the percent by which it raises sugar compared to glucose and is expressed on a scale of 0 to 100. Over the years, the glycemic index has had its share of fans and foes and is still used by people trying to control their blood sugar or body weight.

The factors that affect a foods glycemic index are

i. the fiber and fat, which lowers the glycemic index by slowing digestion and absorption of carbohydrates,
ii. ripeness and processing, which raises it, and
iii. the cooking time and method which impacts it by the type and amount of heat and water, and the duration of cooking.

The History

In 1981, physicians David Jenkins and Thomas Wolever invented the glycemic index by first plotting curves to show how a specific amount of glucose raised the blood glucose of study participants over two hours. They had had participants consume the same amount of carbohydrate via foods and plotted the resulting rise in blood sugar.

Glycemic index seemed to be a useful tool for people with diabetes to control blood sugar, as well to lower cholesterol and triglycerides in people with high blood lipids. Additionally, Wolever found when healthy adults consumed low-glycemic index meals for dinner, they tended to experience lower glycemic responses to carbohydrate at breakfast the next day than they did when they had high-glycemic index meals at dinner.

THE GLYCEMIC INDEX OF SOME FOODS

HIGH-GLYCEMIC INDEX ≥ 70	MODERATE-GLYCEMIC INDEX 56-69	LOW-GLYCEMIC INDEX ≤ 55
❖ White bread	❖ White rice	❖ Whole grains
❖ Watermelon	❖ Grapes	❖ Milk
❖ Corn flakes	❖ Beets	❖ Nuts
❖ Sweet potato	❖ Honey	❖ Eggs
❖ Doughnut	❖ Popcorn	❖ Carrots
❖ Dates	❖ Ice cream	❖ Beans

Since a balanced meal typically contains a blend of foods with different glycemic indices, the glycemic index of an individual food in a total meal may be insignificant. This was a main criticism of the glycemic index, that people usually consume a variety of foods in a single meal. Jenkins and Wolever addressed these concerns in a 1986 study showing how a meal's glycemic index may be calculated. Research participants experience expected rises in blood sugar based on calculated glycemic indices of the meals they eat.

In 2002 Jenkins authored a review paper promoting a low-glycemic index diet for people with diabetes and for reducing cardiovascular disease risk. For individuals with diabetes, the American Diabetes Association says the glycemic index may be used to fine-tune blood sugar, but the amount of carbohydrate a food contains is more important than its glycemic index. Emerging evidence suggests low glycemic diet may help improve insulin sensitivity in children with obesity and elevated insulin as well as to boost short-term weight loss.

The Skepticism

The skepticism about using glycemic index as a dietary tool is that it says nothing about the nutritional value of the food, fibre content, quantities, fat content of the food as well as the timing of the meals. It would be unwise to take a whole bucket of ice-cream rather than a couple slices of watermelon or pineapple due to the low glycemic index of ice-cream, as the fruits also have some additional micronutrients and phytochemicals present and should not be avoided. Ice-cream as well as some high fat fried food may have a low glycemic index due to the high levels of fats and low levels of carbohydrates and should not be taken in excess. The high number of proteins found in some of these low glycemic index foods may also lead to ketoacidosis if taken excessively. All food nutrients should be taken according to the Acceptable Macronutrient Distribution Range (AMDRs).

Using a glycemic index as a weight loss strategy lacks strong evidence. When used in addition to caloric restrictions, a low-glycemic index diet may produce weight loss. However, one of the diet's modern selling points is that users don't have to count calories and can still lose weight, which is a claim yet to be supported. Although the glycemic index is not perfect, it can be a useful tool in addition to evidence-based strategies for controlling blood sugar in people with or at risk for diabetes if they are not unnecessarily restricting foods.

Recommendations

A wellness plan including assessment of all these factors, including other dietary variables, activity levels, age, race, sex and family history, help health care professionals to develop individualized strategies for patients and clients.

References

Grant SM, Wolever TM. Perceived barriers to application of glycaemic index: valid concerns or lost in translation? Nutrients Mar 2011; 3:330e40

Hatonen KA, Virtamo J, Eriksson JG, Sinkko HK, Sundvall JE, Valsta LM. Protein and fat modify the glycaemic and insulinaemic responses to a mashed potato-based meal. Br J Nutr Jul 2011;106: 248e53.

Wolfram T. Understanding the glycemic index. Food and Nutrition Magazine January/February 2019 edition. Pp 25-27.

THE SUGAR DEBATE AND THE WHOLESOMENESS OF FRUIT JUICE

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The sugar question: Is 100-percent fruit juice just another sugary drink?

There are claims that sugar, including the natural sugar present in 100% fruit juice, is to blame for the rise in obesity, cardiovascular disease, and cancer.

Is fruit juice merely another caloric beverage?

Are there concerns about sugar masking fruit juice's benefits for a wholesome diet? Or is pure fruit juice also another sugary drink?

The natural or added forms of sugar in food.

Natural sugars, which are essential to a healthy diet, can be found in dairy products, vegetables, and fruits that are high in nutrients. "Added sugars" are ingredients that are either added to foods and beverages by manufacturers all through processing, or by consumers at the table. These ingredients range from the contentious high-fructose corn syrup to more than 60 ingredients listed by the U.S. Department of Agriculture. Furthermore, added sugars make up an average of 16% of the caloric intake in Ghanaian diets.

Nearly half of all added sugars ingested by Ghanaians are found in sweetened beverages, which have no satiety or nutritional benefit. These include soda, energy drinks, sports drinks, and sweetened "fruit drinks." The human body does not biochemically distinguish between natural and added sugars, despite 100% of fruit juices exclusively containing natural sugars.

The sweet danger of sugar on our health

In terms of health, sugar's reputation is both bitter and sweet. According to Dr. Frank Hu, professor of Nutrition at the Harvard T.H. Chan School of Public Health, "Excess sugar's implications on obesity and diabetes is well researched, but one area that may shock many men is how their taste for sugar can have a huge effect on their cardiovascular health."

Although the precise relationship between sugar and heart health is not fully known, there do appear to be a number of indirect relationships. For example, excessive sugar

overloads the liver. Similar to how it does with alcohol, your liver transforms dietary carbohydrate into fat.

This may result in a higher accumulation of fat over time, which may eventually cause fatty liver disease, a factor in diabetes, which increases your risk of heart disease.

Too much added sugar consumption can promote chronic inflammation and blood pressure, both of which are biological precursors to heart disease. Because liquid calories do not provide the same level of satiety as calories from solid foods, excessive sugar consumption especially added sugar in beverages becomes very easy and the body is deceived into disabling your ability to control your appetite for these sugary beverages. Because of this, it is simpler for people to increase the number of calories in their diet when they drink sugary beverages.

According to Rachel Johnson, Ph.D., RD, a Nutrition professor at the University of Vermont and past chair of the American Heart Association, diets high in added sugars can lead to weight gain, hypertension, chronic inflammation, and elevated triglycerides and LDL cholesterol.

On the contrary, pure fruit juices provide nutrients and bioactive substances that sodas do not. Citrus drinks, such as orange and grapefruit juices, for instance, supply vitamin C, potassium, and fiber when taken with the pulp. Additionally, fortified juices provide a supply of nutrients, such as calcium and folate, that are frequently absent from regular diets.

How much sugar is, okay?

How much in terms of quantity of added sugar is safe? Since sugar is not a necessary nutrient in your diet, it is difficult to say. There is no official sugar RDA set by the Institute of Medicine, which establishes RDAs for other nutrients. The American Heart Association advises that men and women should respectively limit their daily intake of added sugar to 150 calories (about 9 teaspoons or 36 grams) and 100 calories (around 6 teaspoons or 24 grams) respectively. That equates to roughly one 12-ounce can of Coke.

The fruit juice sugar vs whole fruits sugar and instances of obesity and diabetes.

There is conflicting data linking the consumption of fruit juice with cases of obesity and diabetes. A 2014 meta-analysis revealed that fruit juice may not generally affect fasting glucose and insulin concentrations, even though diets with more whole fruits and less fruit juice may lower the incidence of Type 2 diabetes. Additionally, studies reveal that children and adults who consume 100% fruit juice are more likely to obtain the recommended daily amounts of vitamins A and C, folate, magnesium, and potassium.

One cup to two and a half cups of fruits per day, with no more than half in juice form, is advised by the 2010 Dietary Guidelines for Americans. For children aged 1 to 6 years, the American Academy of Pediatrics advises limiting daily fruit juice consumption to 4 to 6 ounces, and for children aged 7 to 12, 8 to 12 ounces. The scenario in Ghana might be different because, according to some research, the majority of Ghanaians often do not consume the required daily amount of fruits (2-4 servings daily). Studies have demonstrated that fruit-derived dietary fiber, or water-soluble fiber, can lower blood cholesterol levels and may lessen the risk of cardiovascular disease. Insoluble fiber from fruits is also important for proper bowel function, and helps to reduce constipation and diverticulosis, and provides a fill with fewer calories.

The Verdict?

Whole fruit is superior to fruit juice because it requires more time to chew, makes you feel fuller for longer, takes longer to digest, and prevents the blood sugar spikes that come with fruit juice. Numerous studies have shown that persons who consume the most fruits and vegetables and exercise more, consume less alcohol, eat more healthy grains, and consume less meat and added sugar are less likely to be overweight.

What is recommended?

Blend whole fruits to reduce sugar and boost fiber in fruit juice. Fruit can be blended with whole vegetables, whole grains, or protein to lower the concentration of sugar and decrease absorption to levels equal to when eating whole fruit. The resulting beverage has the same amount of fiber as the original fruit.

Staying Healthy

Maintaining excellent health is not something that just happens. It necessitates work, wise lifestyle decisions, and sporadic exams and tests.

Fiber, whole grains, fresh fruits, and vegetables, "good" or unsaturated fats, and omega-3 fatty acids are all abundant in a balanced diet. These dietary elements reduce inflammation, which can harm organs, joints, tissue, and artery walls. Another aspect of healthy eating is limiting the intake of processed foods. Blood sugar surges brought on by sweets, highly refined cereals, and beverages sweetened with sugar might result in early hunger. Diabetes, obesity, heart disease, and even dementia have all been related to high blood sugar levels.

Furthermore, healthy living requires physical activity. Your risk of developing heart disease, a stroke, type 2 diabetes, breast and colon cancer, depression, and falling can all be significantly decreased. Sleep, stamina, and even sex are all enhanced by exercise.

References

Kader, Adel A. Quality parameters of fresh-cut fruit and vegetable products. In: Fresh-cut fruits and vegetables. Science, technology, and market. Boca Raton (FL): CRC Press; 2002. p. 11–20.

USDA and US Department of Health and Human Services. Dietary guidelines for Americans, 2010. 7th ed. Washington (DC): US Government Printing Office; 2010.

USDA [Internet]. MyPlate. Washington (DC): USDA; 2011 [cited 2014 Jul 1]. Available from: http://www.choosemyplate.gov.

Roark RA, Niederhauser VP. Fruit and vegetable intake: issues with definition and measurement. Public Health Nutr 2013; 16:2–7.

Moore S, Lloyd B. Improving the comparability of national estimates of fruit and vegetable consumption for cross-national studies of dietary.

Percentage Juice Declaration for Foods Purporting to be Beverages That Contain Fruit or Vegetable Juice, 21 C.F.R. Sect. 101.30 (2013).

Bates RP, Morris JR, Crandall JP. Principles and practices of small and medium scale fruit juice processing [Internet]. FAO Agricultural Services Bulletin 146. Rome (Italy): FAO; 2001 [cited 2014 Jun 20]. Available from: http://ucanr.edu/datastoreFiles/234-2085.pdf

Prasanna V, Prabha TN, Tharanthan RN. Fruit ripening phenomena—an overview. Crit Rev Food Sci Nutr 2007; 47:1–19.

American Academy of Pediatrics (ADA): The use and misuse of fruit juice in pediatrics. Committee on Nutrition. Pediatrics 107: 1210-1213 (2001).

WHAT WE NEED TO KNOW ABOUT FOLATE

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Source: parentinghealthybabies.com

What is Folate?

Folate is a water-soluble B vitamin also known as B9 and folacin. It is a naturally occurring nutrient in foods while folic acid is the synthetic form found in enriched foods and dietary supplements (Watanabe and Miyanake, 2017.).

Folate is best known for its role in the prevention of neural tube defects (NTDs), which are birth defects of the brain and spine, specifically anencephaly and spina bifida. Folate is also an essential nutrient for enzyme reactions in protein and vitamin metabolism (Liew, 2016).

The Role of Folate in Health

In addition to reducing the risk of NTDs, folate is crucial in decreasing the risk of pregnancy complications including anaemia, preterm birth, congenital heart defects and oral clefts.

Roughly 90% of NTDs and 40% of congenital heart anomalies are preventable when women of childbearing age supplement with folic acid pre-conception and post-conception (Zelman, 2019). Timing is important as NTDs occur in the first few weeks of pregnancy.

Though folate is vital during pregnancy, growth, and development, about 35% of non-pregnant women do not meet their dietary intake recommendations without the use of dietary supplements (Zelman, 2019).

Sources of Folate and Folic acid in Ghana

Folate occurs naturally in a variety of foods and many foods are fortified with folic acid. E.g., Dark green leafy vegetables, liver, beans, broccoli, sea foods, fresh fruits and many more. Folic acid is available in multivitamins, prenatal vitamins, singularly and in B-complex dietary supplement.

Both men and women aged 19 years and older should aim for 400mcg DFE. Pregnant and lactating women require 600mcg DFE and 500mcg DFE. People who drink alcohol should aim for 600mcg DFE since alcohol impairs folate absorption.

Signs of Folate Deficiency

- Sores in mouth
- Changes in skin colour, hair, and fingernails
- Fatigue, weakness, and shortness of breath

Toxicity

This could result by exceeding the upper limit (1000mcg) which leads to high levels of unmetabolized folic acid in the blood (Zelman, 2019).

Bottom line

Diet alone may not provide adequate folate for women of reproductive age. Women in such age groups should eat a folate-rich diet and take folic acid supplements before conception and continue throughout pregnancy.

References:

Hiroko W. and Tomoko M. (2017), World's largest Science, Technology & Medicine Open Access book publisher Folic and Folate Acid.

Liew, S. (2016). Folic acid and diseases – supplement it or not? 62(1), 90–100.

Article referenced from; Kathleen Zelman, MPH, RDN. Food and Nutrition Magazine September/October 2019 edition.

https://www.nhc.com/folic-acid

https://my.clevelandclinic.org/health/diseases/22198-folate-deficiency

Recommended Amounts

Age	Male	Female	Pregnancy	Lactating
0–6 months*	65 mcg DFE*	65 mcg DFE*		
7–12 months*	80 mcg DFE*	80 mcg DFE*		
1–3 years	150 mcg DFE	150 mcg DFE		
4–8 years	200 mcg DFE	200 mcg DFE		
9-13 years	300 mcg DFE	300 mcg DFE		
14–18 years	400 mcg DFE	400 mcg DFE	600 mcg DFE	500 mcg DFE
19+	400 mcg DFE	400 mcg DFE	600 mcg DFE	500 mcg DFE

**Adequate Intake (AI)*

Source: www.nhc.com/folic-acid
DFE=Dietary Folate Equivalents, mcg-Microgram

FERTILITY AND FOOD; FACTORS TO CONSIDER FOR CONCEPTION

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What is about diet and fertility?
Research on the influences of diet and other lifestyle factors on fertility has increased dramatically over the last few decades. Nowadays, many cases of infertility are prevented and treated with the help of nutrition and lifestyle modifications. The environment in which eggs and sperm develop, as well as hormone levels involved in reproductive processes, are the main ways that nutrient intake from food and dietary supplements, calorie intake, and body fat affect fertility.

What is fertility?
According to the World Health Organization (W.H.O), fertility refers to the preconception period of a reproductive-aged woman (15 – 49yrs) during which she is trying to get pregnant. Infertility on the other hand, is when a couple after 12 months or more of regular unprotected sexual intercourse fails to get pregnant.

The experience of infertility can exact a significant physical, psychosocial, and economic toll on couples. Although infertility is often associated with women, male physiological factors have been shown to be responsible for approximately 25% of cases, underscoring the need to consider both partners. Despite increased usage of assisted reproductive technologies (ART) in recent years, the prevalence of infertility has remained high. As such, a great deal of study has aimed to identify modifiable risk factors for infertility; to date, nutritional factors have been the subject of much of these investigations.

The Statistics
American statistics shows that, 6% of married women up to 49 years old are unable to get pregnant after a year of trying and 12% of all women have difficulty getting pregnant or carrying a pregnancy to term known as "impaired fecundity.

Ghana had a fertility rate of 3.8 children per woman in 2020. According to World Bank data, this rate significantly decreased from 7 per woman in 1970 to 3.8 in 2020. Infertility rates for women in Ghana were reported to be 2% for primary infertility and 14% for secondary infertility (ACCOG, 2014).

It is worth noting that with aging, fertility gradually decreases. However, infertility is not a female-specific illness. 35% of marital infertility is caused by male and female associated variables, and in 8% of those cases, the male element is the clearly recognized cause. There is no one-size-fits-all treatment because the causes of infertility are diverse.

Causes of Infertility of Females
Globally, infertility is mainly due to conditions affecting female reproductive system such as, Polycystic Ovary Syndrome, endometriosis, primary ovarian insufficiency, structural uterine abnormalities, blocked fallopian tubes, uterine fibroids, excess body weight and overactivity, eating disorders, stress (causing a condition known as hypothalamic amenorrhea).

Causes of Infertility of Males

For males, infertility factors are often related to varicocele (a condition in which a man's testicles are too large and cause the testicles to overheat). The elevated temperature can affect the shape, movement and quantity of sperm. Other factors include genetic condition that affect sperm production, injury to the testicles and cystic fibrosis.

Dietary Recommendations for Women

Based on research, a high fertility diet consists of, low intake of trans fat and greater intake of monounsaturated fat, greater plant consumption and lower animal protein consumption, greater consumption of complex, high fiber carbohydrates, consumption of full-fat dairy products rather than low fat dairy foods and greater consumption of non-heme iron foods from plant sources.

Dietary Recommendations for Men

Foods that can improve semen quality includes, seafoods, poultry, whole grains and low-fat dairy products while decreasing consumption of red and processed meats, foods and beverages with added sugar and high fat dairy products.

Additional consideration for fertility.

In addition to these factors, lifestyle choices and recreational activities can also affect both male and female fertility.

Body weight: For patients with overweight or obese BMIs, there are advantages of dietary changes and physical activity for lowering the risks of having more body mass and for maintaining pre-conceptional health. For people who have underweight BMIs, better nutrition might improve fertility and the health of their unborn child.

Fitness: We can combine two days of strength training with 150 to 300 minutes a week of moderate intensity exercise. Seek permission from your doctor before engaging in any form of exercises, especially if you are undergoing an ART procedure.

Alcohol, smoking and drug use: According to the American Society for Reproductive Medicine committee, men and women seeking improved fertility should abstain from smoking. It also is recommended to avoid alcohol or recreational drug use.

Caffeine: Female patients should consume no more than 200 milligrams of caffeine per day, roughly the amount in a 12-ounce cup of coffee. Research is inconsistent regarding male fertility and caffeine.

Conclusion:

More research on the preconception period is needed to further identify the roles of nutrition and lifestyle habits, and specific recommendations will continue to evolve for both female and male fertility — as well as how to improve success rates of ART procedures.

References

Bitler M, Schmidt L. Health disparities and infertility: impacts of state-level insurance mandates. Fertil Steril. (2006) 85:858–65. doi: 10.1016/j.fertnstert.2005.11.038

Cousineau, T. M., & Domar, A. D. (2007). Psychological impact of infertility. Best practice & research. Clinical obstetrics & gynaecology, 21(2), 293–308. https://doi.org/10.1016/j.bpobgyn.2006.12.003

Thoma ME, McLain AC, Louis JF, King RB, Trumble AC, Sundaram R, et al. Prevalence of infertility in the United States as estimated by the current duration approach and a traditional constructed approach. Fertil Steril. (2013) 99:1324–31 e1. doi: 10.1016/j.fertnstert.2012.11.037

Salas-Huetos A, Bullo M, Salas-Salvado J. Dietary patterns, foods and nutrients in male fertility parameters and fecundability: a systematic review of observational studies. Hum Reprod Update (2017) 23:371–89. doi: 10.1093/humupd/dmx006

Gaskins AJ, Chavarro JE. Diet and fertility: a review. Am J Obstet Gynecol. (2018) 218:379–89. doi: 10.1016/j.ajog.2017.08.010

Yaw Osei N. (2014). Association of Childless Couples of Ghana (ACCOG). Facts, Views & Vision in ObGyn, 6(2), 99–102.

Elizabeth Shaw. Food and Nutrition Magazine (2019, May/June) Page 20,21.

The World Bank Data https://data.worldbank.org/indicator/SP.DYN.TFRT.IN?locations=GH

HAND HYGIENE; AN INDISPENSABLE TOOL FOR SUSTAINABLE INFECTION CONTROL

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Source: OSHA NOTICE

"Hand hygiene is the first basic step towards achieving any millennium goals for development. It saves lives."
— Kajol.

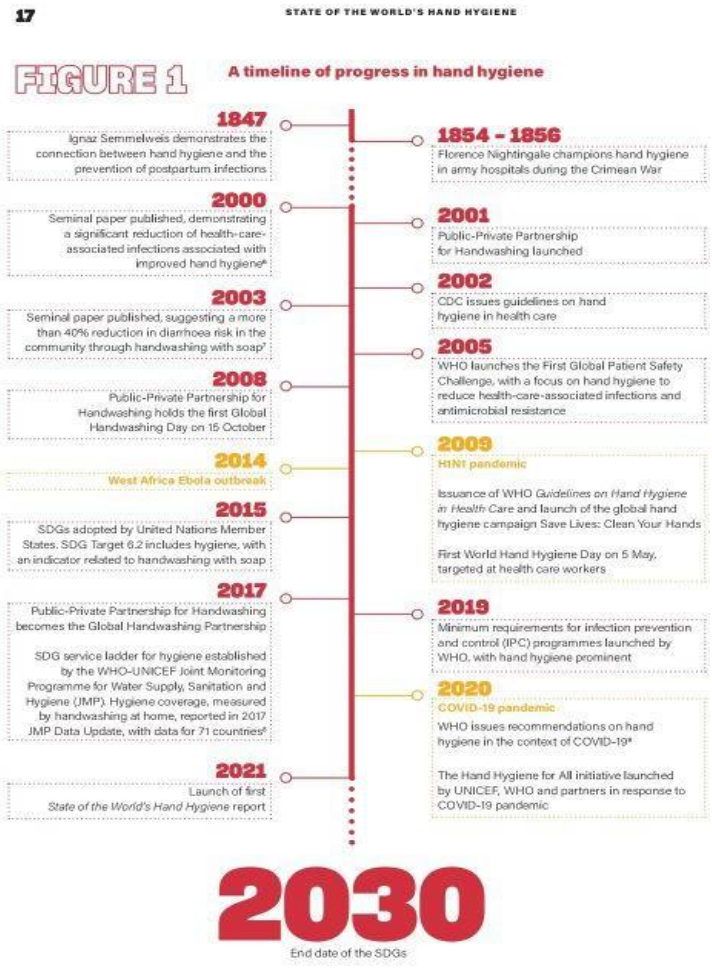
Overview of Hand Hygiene

Growing up, we have been taught to wash our hands regularly. Washing hands before dinner and after using the bathroom has been a common principle for every child. Despite efforts to promote hand hygiene, hand washing remains a stubbornly low practice. It is estimated that 1.9 billion people will not be able to wash their hands at home by 2030 if current trends continue (UN, 2021). Considering a study conducted by USDA in 2018, Majority of consumers studied failed to correctly wash their hands 97 percent of the time which was attributed to the failure to wash their hands long enough. The study predicted that 95% of the world's total population do not practice this simple act correctly (USDA, 2018). As part of SDG 6's quest to achieve access to hygiene for all by 2030, hand hygiene is one of the most important elements. Despite this, many settings lack the facilities and support to practice hand hygiene (WHO, 2021). Globally, 2.3 billion people (3 out of 10 people) lack a facility at home for washing their hands, including 670 million who don't have any. These facilities are also absent in many health care centers, schools, and public places (World Hand Hygiene Day,2021). Google searches for "washing hands" and "hand sanitizer" have increased since February 2020 (Berardi et al., 2020), indicating the need for public education and guidelines on hand hygiene.

All types of viruses and bacteria can be picked up by an individual throughout the course of the day from a variety of objects and people (Michael Loughlin, 2018). Most workers go from home to work (office), which is to say from bed to desk. A room or office is typically assessed by sight and smell, not by its invisible microbiology, which is where infection risks reside (Almanza et al, 2015). Humans are the most prevalent source of germs at the workplace, according to research from the University of Arizona. Men have been been found to have three to four times as many bacteria in, on, and around their desks, phones, computers, keyboards, drawers, and personal things as women do. (Hewitt et

al.,2012). Most people spend a great deal of time on the keyboard and mouse at work, which unsurprisingly leads to both deposits and pick up of microorganisms. There are 20,961 bacteria per square inch on the typical desktop. Additionally, there are 3,295 on the keypad, 1,676 on the mouse, and a startling 25,127 germs on the phone. (Kwok et al, 2015). Less thought is given to what resides on our beds, nightstands, phones, kettles, coffee makers, light switches, and TV these surfaces are not always sanitized in between occupants. In addition to being challenging to clean, soft fabric furnishings like cushions, chairs, blinds, and curtains sometimes can't even be sanitized beyond stain removal. According to Kwok et al., 2015, the average office desk is said to contain 400 times more germs than a toilet seat. Consequently, many office workers could be at risk of sickness due to dirty desks. Tummy bugs, diarrhoea and vomiting along with respiratory viruses, such as colds and pneumonia, as well as COVID-19 are common infections people pick up from bedrooms and offices. (WHO, 2021).

The hands are the main route by which 80% of cross-infections occur (Elliot, 1992). Hands play a significant role in spreading pathogens which are usually transmitted through the air or via surfaces (Jabr, 2020). According to WHO (2021), unhygienic hands remain the leading cause in the rise of healthcare-associated infections, Stunting and Sepsis. A person may touch their eyes, nose, and mouth unintentionally every 2.5 minutes, opening the door for potentially harmful microorganisms to enter their internal organs, according to one study (Kwok et al., 2015).



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Amid the battle against unseen microbes, the simple act of cleaning hands regularly can save a lot of lives and reduce illness by preventing the spread of infectious diseases (WHO, 2021). Half a million people have been estimated to die each year from these diseases which could have been prevented with good hand hygiene as well as preventing a multitude of diseases (WHO, 2021).

As the basis of daily hygiene, hand hygiene has relatively been widely used recently. During the COVID-19 pandemic, hand hygiene became a central pillar in national COVID prevention strategies but matters on hand hygiene has been evolving from 1854 (Lin Y-H, 2020). Oliver Wendell Holmes in the US (1843) and Semmelweiss (1861) in Europe reported on the relationship between hand washing and direct transfer of infection. They both demonstrated a drop in the rate of puerperal sepsis and its associated mortality when medical staff washed their hands between examining women during childbirth. Florence Nightingale, an English nurse, and statistician, also advocated for handwashing in the mid-1800s, but it wasn't until the 1980s that the U.S. Centers for Disease Control and Prevention announced the first global national recommended guidelines for hand hygiene.

Hand hygiene should be a vital everyday behavior that contributes to health and economic resilience and not only a temporary public health measure in times of crisis. It is a cost-effective investment which can provide outsized health benefits.

What does the hands carry?

Most germs are transferred through direct or indirect contact with contaminated hands or surfaces. Pfizer (2019) records that on the average, the hand is the carrier of 3,200 different germs belonging to more than 150 species of two main categories of microorganisms.

These includes

Resident Microorganisms (normal flora): These microorganisms are deep rooted in the epidermis and do not readily cause disease unless under certain invasive procedures. Example: Staphylococcus epidermidis

Transient Microorganisms: These micro-organisms represent contamination of the hands through touching or interacting with people and things around. Example: E. coli, Klebsiella, Pseudomonas spp, Salmonella.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7301780/

Mechanism of Hand Hygiene

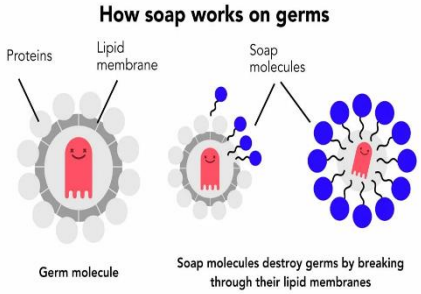
The proper manual handwash involves eight steps with 13 different actions as proposed by WHO guidelines for hand hygiene. The effectiveness of hand hygiene depends on application of an adequate volume of a suitable hand hygiene accompanied with good technique for the appropriate duration of time, and also ensuring that the hands are properly dried.

Effective hand Washing Method. www.cdc.gov.hand washing

Social, antiseptic, and surgical hygiene are three levels of Hand Hygiene that are recommended to ensure that the hand is suitable for the task being undertaken. Social hand hygiene consists of hand washing and gand sanitizing. Hand washing with soap and clean water is necessary to remove dirt, organic materials as well as other transient organisms. Hand sanitizing (alcohol washing) on the other hand, is used in substitution when the hands are clean to inactivate or temporarily suppress micro-organisms (Jing et al., 2020). It also reduces resident bacteria or viruses that typically live on the surface.

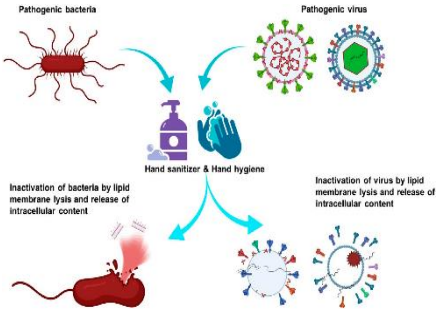
How soap and sanitizer work?

During hand washing with soap and water, microorganisms on the skin are surrounded with soap molecules. The hydrophobic tail of the free-floating soap molecules attempts to evade water; in the process, it wedges themselves into the lipid envelopes of certain microbes and viruses, prying them apart. The spilling of essential proteins from the ruptured membranes into the surrounding water, kills the bacteria and renders viruses useless. Simultaneously, some soap molecules break the chemical bonds that allow bacteria, viruses, and grime to stick to surfaces, removing them off the skin.



https://pubmed.ncbi.nlm.nih.gov/32337862/

Hand sanitizers are not as reliable as soap. Sanitizers containing at least 60% ethanol wo by destabilizing the lipid membranes of the microorganisms, but they cannot simply remove microorganisms from the skin (Jabr, 2020). This means sanitizing a dirty hand is not effective.



https://medicine.yale.edu/news-article/why-soap-works/

Rigorous scrubbing with soap and water is required to expunge more resilient microbes like viruses that do not depend on lipid membranes to infect cells, as well as spore-forming bacteria that are generally less susceptible to the chemical onslaught of ethanol and soap. Examples: Diarrhea and skin infections bacteria and adenovirus (Jabr, 2020).

Effective Hand Hygiene

Scientific evidence clearly demonstrates that appropriate hand hygiene is not only a key solution for preventing the spread of germs, but it also reduces the burden of health care-associated infections as well as the spread of antimicrobial resistance.

Appropriate hand hygiene prevents up to 50% of avoidable infections acquired during health care delivery (WHO, 2021). Good hand hygiene entails effective removal of germs from hands. From World Health Organization's guidelines on effective handwashing, it quickly becomes clear that variability naturally occurs with human behavior and lack of appropriate facilities. Despite the sensitization on how to wash the hands correctly, it is extremely difficult for an individual to get this right every time, even with repeated training making it practically impossible to do it the exact same way. The truth of the matter is that very few people wash their hands properly; and everyone does it differently.

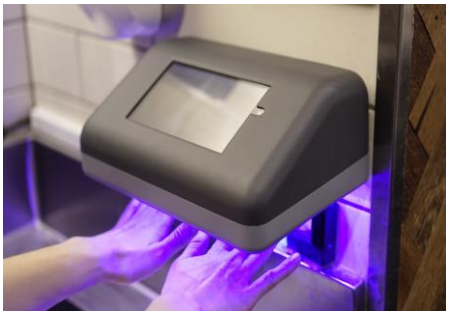
According to WHO (2021), compliance with hand hygiene best practices is only around 9% in low-income countries while levels of hand hygiene compliance for high-income countries rarely exceed 70%, calling for additional efforts to improve practices all over the world. Numerous studies conducted on barriers to effective hand hygiene reveal that, lack of knowledge, incorrect behavior patterns, insufficient training, heavy workloads, poorly designed work environment and low-quality equipment remain the leading cause of non-compliances with effective hand hygiene. The results of a study of millions of hand scans on frequently missed areas during washing revealed 6 commonly missed hand washing hotspot; under fingernails, the wrist area, around jewelry, and the webbing of hands (pathspot, 2014).

https://kottke.org/20/02/map-of-areas-most-often-missing-during-handwashing

Innovation

Trending studies on hand hygiene are focused on aspects which have attracted little attention, such as hand drying and cultural issues determining hand hygiene. Owing to behavioral differences and the variability in the practice of hand hygiene in humans leading to increasing rates of non-compliance with the WHO guidelines on hand hygiene. Several innovations have seen breaking the barriers by \making hand hygiene practice and its measurement easier and consistent. For example, the existence of the automated touch-free technology, which removes more than 99.9% of pathogens while saving time and resources. Also, the pathspot hand wash monitoring device can detect E. coli, salmonella, norovirus, hepatitis A, and listeria and Cloudclean real-time handwash monitoring system. This technology is revolutionizing hand hygiene practice in restaurants and food industries.

Automated hand wash. https://wrdwells.com/product-category/meritech-hand-footwear-hygiene/cleantech-automated-handwashing-station/



Pathspothand washing monitoring system, https://images.app.goo.gl/HBaJB5GsHYmsHuMC6

Conclusion

Hand hygiene must be part of an integrated approach to infection. It is the foundation for the existence of any sector of life. Just an impulse to bypass the sink can cost the lives of millions of people.

References

Almanza, B. A., Kirsch, K., Kline, S. F., Sirsat, S., Stroia, O., Choi, J. K., Neal, J. (2015). How Clean Are Hotel Rooms? Part I: Visual Observations vs. Microbiological Contamination. Journal of Environmental Health, 78(1), 8–13. https://www.jstor.org/stable/26330308

Berardi A, Perinelli DR, Merchant HA, Bisharat L, Basheti IA, Bonacucina G et al (2020) Hand sanitisers amid covid-19: a critical review of alcohol-based products on the market and formulation approaches to respond to increasing demand. Int J Pharm 584:119431–119431. https://doi.org/10.1016/j.ijpharm.2020.119431

Hewitt, K.M., Gerba, C.P., Maxwell, S.L. and Kelley, S.T., 2012. Office space bacterial abundance and diversity in three metropolitan areas. PloS one, 7(5), p.e37849.

Jing T., Pei T., Bose T., McCarthy RJC., 2020. Hand Sanitizers: A review on formulation aspect adverse effect and regulations. Int J Environ Res Public Health, Volume E3326, p. 17.

Jabr, F., 2020. Why Soap Works. [Online] Available at: https://medicine.yale.edu/news-article/why-soap-works/#:~:text=When%20you%20wash%20your%20hands,and%20viruses%2C%20prying%20them%20apart [Accessed 12 November 2022].

Kwok, Y.L.A., Gralton, J. and McLaws, M.L., 2015. Face touching: a frequent habit that has implications for hand hygiene. American journal of infection control, 43(2), pp.112-114.

Lin Y-H,Liu C-H,Chiu Y-C 2020. Google searches for the keywords of "wash hands" predict the speed of national spread of COVID-19 outbreak among 21 countries. Brain Behav Immun ,30–32. (https://doi.org/10.1016/j.bbi.2020.04.020), p. 87.

Michael Loughlin (2018), How clean is your desk? The unwelcome reality of office hygiene[online]. Available at https://theconversation.com/how-clean-is-your-

desk-the-unwelcome-reality-of-office-hygiene-99099

Sayeed A., Rahman, M.H., Bundschuh, J., Herath, I., Ahmed, F., Bhattacharya, P., Tariq, M.R., Rahman, F., Joy, M.T.I., Abid, M.T. and Saha, N., 2021. Handwashing with soap. Groundwater for Sustainable Development, Volume 13, p. 100561.

United Nations Summary Progress Update 2021: SDG 6 — water and sanitation for all

World health Organization, Key facts and figures, World Hand hygiene day 2021[online] Available at: https://www.who.int/campaigns/world-hand-hygiene-day/2021/key-facts-and-figure-onlinccessed 15 June 2023]

World Health Organization 2021. State of the world's hand hygiene. : A global call to action to make hand hygiene a priority in policy and practice., p. 88.

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