INVESTIGATING THE MODULATORY ROLE OF COMMONLY USED FOOD SEASONING (KNORR CHICKEN CUBE) ON SURVIVAL RATE AND SELECTED ANTIOXIDANTS IN DROSOPHILA MELANOGASTER

BY

AYEMERE PRECIOUS OMONIGHO

BMS2005025

THE DEPARTMENT OF MEDICAL LABORATORY SCIENCE

FACULTY OF BASIC MEDICAL SCIENCES

UNIVERSITY OF BENIN

BENIN CITY, EDO STATE.

OCTOBER, 2025.

INVESTIGATING THE MODULATORY ROLE OF COMMONLY USED FOOD SEASONING (Knorr Chicken Cube) ON SURVIVAL RATE AND SELECTED ANTIOXIDANTS IN THE MELANOGASTER

BY

AYEMERE PRECIOUS OMONIGHO

BMS2005025

THE DEPARTMENT OF MEDICAL LABORATORY SCIENCE

FACULTY OF BASIC MEDICAL SCIENCES

UNIVERSITY OF BENIN

BENIN CITY, EDO STATE.

A PROJECT SUBMITTED TO THE DEPARTMENT OF MEDICAL LABORATORY SCIENCE, UNIVERSITY OF BENIN IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF MEDICAL LABORATORY SCIENCE (BMLS) DEGREE.

SUPERVISED BY:

PROF. O.G. IGHARO.

OCTOBER, 2025.

CERTIFICATION

This is to certify that this project work was satisfactorily carried out BY AYEMERE PRECIOUS OMONIGHO with matriculation number BMS2005025, of the Department of Medical Laboratory Science, School of Basic Medical Sciences, under my supervision . This project was completed in partial fulfilment of the requirement for the award of the Bachelor of Medical Laboratory Science (BMLS) degree.

_____ _____

PROF O.G IGHARO **DATE**

PROJECT SUPERVISOR

_____ _____

DR. (Mrs) Z. OMORUYI **DATE**

(HEAD OF DEPARTMENT)

_____ _____

EXTERNAL EXAMINER **DATE**

DECLARATION

This project work is dedicated to Jehovah, who has been my strength and anchor during the course of my undergraduate studies. I also dedicate it to my parent, siblings and friends for their constant motivation and companionship throughout this career path.

ACKNOWLEDGEMENT

First and foremost my thanks goes to Jehovah who gave me strength during the course of writing my project work and carrying out its analysis.

My profound gratitude goes to my supervisor Prof O.G IGHARO for his constructive guidance and valuable ideas which aided my project work. Thank you sir for your scholarly contributions.

I extend my sincere gratitude to Dr. J. Osakue for always being available and providing unwavering support throughout the course of my project.

Special appreciation goes to the head of department, Dr. (Mrs) Z. Omoruyi for her unwavering support. Your constant care and love for the department is unmatchable.

I would love to appreciate my parents, Mr and Mrs Ayemere for their constant prayers and endless funds towards the success of this project. This project would have been impossible without my lovely siblings:Samuel and Glory Ayemere who voluntarily supported my work monetarily and guided me the best way,your unwavering support and love Is something I deeply value. This list would be incomplete without mentioning my amiable friends:Micah, Susan, Joy, Nathan,Ekhator and my women for being true friends.

I would like to thank the management of the Department of Chemical Pathology, University of Benin for their support towards the success of this project.

I am also grateful to my colleagues for making this journey a memorable one. Thanks to you all.

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

The growing consumption of processed seasoning, particularly Knorr, has raised scientific concern regarding their potential physiological effects, owing to the inclusion of additives such as monosodium glutamate (MSG), high salt content and synthetic flavor enhancers.This study investigated the effects of Knorr seasoning on Drosophila melanogaster across different concentrations. The flies were allocated into five groups: Group A (control), Group B (0.3 g), Group C (0.15 g), Group D (0.1 g), and Group E (0.05 g). Survival analysis revealed that Knorr seasoning significantly influenced lifespan ($p = 0.006$). Flies exposed to the highest concentration (0.3 g) exhibited the lowest survival rate by Day 21 (8.3%), whereas those treated with the lowest concentration (0.05 g) maintained a relatively higher survival rate (20.0%) compared to the control group (22.9%). A second setup was made and the flies was divided into five groups with varying concentrations to assess antioxidant enzyme activity. Catalase (CAT) activity showed no significant differences among groups ($p = 0.624$), while superoxide dismutase (SOD) activity varied significantly ($p = 0.012$). Glutathione peroxidase (GPx) activity did not differ significantly across treatment groups ($p = 0.984$).

Overall, the findings demonstrated that Knorr chicken seasoning reduced the survival of Drosophila melanogaster in a concentration-dependent manner, with the greatest reduction observed at 0.3 g. Antioxidant enzyme assays indicated that Knorr seasoning selectively modulated SOD activity, suggesting heightened oxidative stress responses at higher concentrations and reduced activity at intermediate levels, whereas CAT and GPx activities remained largely unaffected. These results emphasize the critical role of dosage in determining whether Knorr seasoning exerts detrimental or potentially adaptive biological effects. Further investigations are warranted to validate these findings and explore the long-term health implications of seasoning cube consumption.

CHAPTER ONE

INTRODUCTION

1.1 Background of Study

Seasonings play a central role in culinary traditions worldwide, serving not only to enhance the sensory qualities of food but also to influence physiological processes within the body. Knorr seasoning, a widely consumed product manufactured by Unilever, is a common additive in Nigerian households and many other regions of the world. Its formulation includes ingredients such as monosodium glutamate (MSG), salt, yeast extract, and a blend of herbs and spices. These constituents have been reported to exert varying biochemical effects, ranging from antioxidant to pro-oxidant activities, depending on their concentration and dietary context(Martinez ,2024).

In recent years, attention has increasingly shifted toward the potential health consequences of processed seasonings. Concerns have been raised particularly about their high sodium levels, MSG content, and the presence of other food additives. While certain herbal components, such as turmeric and rosemary, are known for their antioxidant properties, other constituents like MSG and hydrolyzed proteins have been associated with oxidative stress, altered metabolic pathways, and adverse health outcomes in experimental models(Walter ,2025). The heightened presence of processed foods in human diets has brought attention to possible health risk, particularly due to high levels of salt, preservatives, flavor enhancers, and synthetic additives. Knorr chicken seasoning, a widely consumed seasoning product, are rich in sodium, monosodium glutamate (MSG), disodium inosinate and other compounds that can influence metabolism and cellular function. While such additives enhance taste, their biochemical and physiological effects, especially over prolonged exposure, remain underexplored with little scientific understanding.

Drosophila melanogaster, known colloquially as the fruit fly, remains one of the most commonly used model organisms for biomedical science. For more than one hundred years, the low cost,rapid generation time, and excellent genetic tools have made the fly indispensable for basic research.

The addition of numerous molecular tools has allowed the model system to keep up with the latest advances.Previous research indicates that various food additives and plant-derived extracts can significantly affect survival rates and modulate the activities of antioxidant enzymes in fruit flies. This makes Drosophila a valuable system for assessing the biological effects of dietary seasonings(Suh *et al*., 2017).

The research could investigate the effects of seasoning cube component on fly development, looking at factors like larva growth pupation time and adult emergence. Additionally the study could access the impact on fly health, potentially examining survival rates, stress resistance, observable developmental abnormalities and selected antioxidant.The study cold also investigate the potential toxicity of knorr chicken seasoning and their components, which could aid in understanding the potential health consequences of consuming this seasoning.

Model organisms like Drosophila melanogaster offer a unique opportunity to study dietary impacts due to their well-characterized genome, short life cycle, and conserved metabolic pathways that mirror those in higher organisms. Historically, Drosophila has been instrumental in advancing our understanding of nutrition, metabolism, and oxidative stress (Pandey and Nichols, 2011).

Antioxidant enzymes such as superoxide dismutase(SOD), catalase(CAT), and glutathione peroxidase(GSH) play critical roles in combating oxidative stress and maintaining cellular health. Measuring the activity level of these enzymes serves as a useful indicator of oxidative damage or protection(Halliwell and Gutteriddge, 2015). Therefore studying the modulatory

effects of knorr cubes on survival and antioxidant status in Drosophila can provide insight into the biochemical consequences of common dietary practices.

Given the widespread use of processed food additives, this study will provide insights into their broader implications on health and offer strategies to mitigate potential adverse effects through antioxidant interventions. Furthermore, findings from this study may inform regulatory guidelines and public health recommendations regarding processed food consumption.

1.2 Statement of Problem

The widespread consumption of bouillon cubes, such as Knorr chicken, has become an integral part of dietary habits in many households due to their flavor-enhancing properties. These cubes are rich in salt, monosodium glutamate (MSG), and other artificial additives that are designed to improve taste but may have unintended biological effects when consumed in large quantities or over prolonged period .In Nigeria, as in many other developing countries, Knorr seasoning is widely used as a household flavor enhancer. However, its formulation—comprising monosodium glutamate (MSG), salt, and other synthetic additives—has prompted questions about its long-term biological effects. Although MSG is classified as generally safe by regulatory authorities, several studies have linked excessive intake to oxidative stress and related health risks.

While studies have explored the health implications of these additives in mammals, their impact on smaller model oranisms like Drosophila melanogaster remains underexplored. Drosophila melanogaster, a model organism with well-characterized genetics and conserved metabolic pathways, provides an excellent system to study dietary and environmental impacts on health. While this seasoning are considered safe in regulated amounts, there is growing concern about their impact on oxidative balance and organismal health, especially when consumed frequently. However, there is insufficient scientific evidence regarding their

influence on key biological parameters such as survival rate and oxidative stress markers. Evidence suggests that dietary additives can influence antioxidant enzyme activities and survival outcomes in Drosophila, making it an appropriate system for assessing the biological impacts of food seasonings(Bag and Mishra, 2019) This study addresses the gap by evaluating how Knorr affects antioxidant enzyme activity and lifespan in Drosophila melanogaster.

Oxidative stress occurs when the production of reactive oxygen species (ROS) overwhelms the body's antioxidant defense mechanisms, leading to cellular damage, accelerated aging, and disease progression. Antioxidant enzymes, including superoxide dismutase (SOD) and catalase (CAT), play a central role in mitigating ROS and preserving cellular integrity. Disruption of these defense systems may significantly compromise survival and longevity((Deepashree *et al.*, 2021).

Even with the broad usage of these seasoning cubes, little is known about their biochemical and physiological effects, particularly at the cellular level or in relation to oxidative stress and microbiota dynamics. This knowledge gap poses a challenge for assessing the safety and long-term health implications of consuming such processed food products.

1.3 Justification of study

This study uses Drosophila melanogaster to investigate the survival rate of varying concentrations of Knorr chicken seasoning,quantity enzymes like catalase , Glutathione peroxidase and superoxide dismutase. This is essential in assessing the potential risk associated with Knorr chicken consumption as diet as a profounding influence on the metabolism of animals.

Using Drosophila melanogaster as a model organism provides a reliable approach for assessing the potential toxicological effects of Knorr chicken seasoning. Owing to its genetic similarity with humans sharing over 60% of genes Drosophila facilitates the exploration of

molecular and genetic mechanisms that may reflect human biological processes (Adams *et al*., 2000). Its rapid life cycle, amenability to genetic manipulation, and well-established role in oxidative stress research further underscore its suitability for toxicological investigations (Bellen *et al*., 2010).

The justification for this study stems from the urgent need to address existing knowledge gaps regarding the possible health risks associated with Knorr chicken seasoning consumption. Findings from this research are anticipated to support the formulation of stronger food safety regulations, improve public health awareness, and contribute to the development of safer alternatives to conventional food additives.

1.4 Aim of study

The aim of the study is to investigate the modulatory effects of Knorr chicken seasoning on survival rate and selected antioxidant enzymes such as Superoxide dismutase(SOD) ,Catalase(CAT) and Glutathione peroxidase (GPX) in Drosophila melanogaster.

1.5 Research questions

1. What is the impact of varying concentrations of knorr chicken seasoning on the survival rate of Drosophila melanogaster?
2. What are the effects of knorr chicken seasoning on exposure to the antioxidants enzymes such as Catalase, Superoxide dismutase and glutathione peroxidase?
3. Does dietary supplement with knorr chicken seasoning influence the lifespan of Drosophila melanogaster in comparison to untreated controls?.

1.6 Research objective

1. To investigate the physiological and behavioral effects of knorr maggi cube on Drosophila Melanogaster, focusing on some specific stress markers.
2. What are the behavioural changes of Drosophila melanogaster after consuming the media containing Knorr maggi cube.

1.7 Null hypothesis(Ho)

The addition of Knorr chicken seasoning has no significant effect on the survival rate and antioxidant enzyme activity(such as superoxide dismutase,catalase and thiorodexin peroxidase) in Drosophila melanogaster.

1.8 Alternative Hypothesis(H1)

The addition of Knorr maggi cube has a significant effect on the survival rate and antioxidant enzyme activity in Drosophilia melanogaster.

1.9 Scope of study

The study aims to examine the survival rate and activity of selected antioxidant enzymes of Knorr chicken seasoning in Drosophila melanogaster.

CHAPTER TWO

LITERATURE REVIEW

2.1 Drosophila melanogaster as a model organism

2.1.1 History and Biology of Drosophila melanogaster

Drosophila melanogaster, commonly referred to as the fruit fly or vinegar fly, is an African-origin species, with all non-African populations tracing back to a shared ancestral lineage [Baudry *et al* ,2004). The name Drosophila is derived from modern scientific Latin, adapted from the Greek words δρόσος (drósos, meaning "dew") and φιλία (philía, meaning "lover"), thus signifying "dew-loving." Similarly, the species epithet melanogaster translates to "black-belly," originating from the Greek μέλας (mélas, meaning "black") and γαστήρ (gastḗr, meaning "belly"). The species' prominence as a model organism in biological research began around 1900–1901. As noted in Thomas Hunt Morgan's biography (Thomas H Morgan), the American entomologist Charles William Woodworth was the first to successfully breed the insect in captivity at Harvard University. He subsequently recommended its use in genetic studies alongside mice to William Ernest Castle, following Castle's independent rediscovery of Gregor Mendel's work in 1900. Drosophila melanogaster is a small insect belonging to the order Diptera. In natural environments, these flies are frequently observed in orchards and domestic spaces such as kitchens, where they are attracted to fermenting organic matter(Admin, 2022). Taxonomically, the species is classified as follows:

- Kingdom: Animalia
- Phylum: Arthropoda
- Class: Insecta
- Order: Diptera
- Family: Drosophilidae
- Genus: Drosophila

- Subgenus: Sophophora

Drosophila melanogaster has long been a favorite in research laboratories and for good reason. These tiny insects combine practical advantages with significant genetic similarities to humans, making them a reliable model for many biological studies. One major benefit is that they are not subject to the same ethical concerns as mammalian models, such as monkeys or mice.

The decision to use Drosophila as a research model dates back to the early 1900s, although it's hard to pinpoint the exact moment it gained traction. However, the story of its rise is well recorded. It began with Thomas Hunt Morgan, who used the fruit fly to demonstrate that genes are located on chromosomes (Tolwinski , 2017).

Additionally, the genome of Drosophila is fully mapped, and there are many available strains with specific mutations. Scientists also have access to powerful genetic tools that allow them to study gene functions in detail.

All of these traits make Drosophila melanogaster an ideal organism for studying how dietary substances like Knorr chicken seasoning might affect survival, antioxidant activity, and oxidative stress responses.

2.2.1 Life cycle of Drosophila melanogaster

The Drosophila life cycle is comprised of the following developmental changes:

Embryogenesis

Embryogenesis in Drosophila melanogaster is a rapid process completed within approximately 24 hours after fertilization of the oocyte by the sperm (Hales *et al*., 2015). Following fertilization, the single-cell zygote develops into a syncytial embryo. During this stage, rapid DNA replication and nuclear divisions occur, producing up to 5,000 nuclei within the shared cytoplasm. Subsequent migration of the nuclei to the periphery initiates cellularization, forming the syncytial blastoderm in a process termed cleavage. Gastrulation

follows, during which cells undergo morphological changes and migration to establish the three primary germ layers mesoderm, endoderm, and ectoderm that define the future body plan. Detailed accounts of cleavage and gastrulation can be found in (Lewis *et al*., 2015) or through live cell imaging studies of Drosophila embryos. The egg of Drosophila melanogaster measures approximately 0.5 millimeters in length. Its outer membrane ,known as the chorion, is opaque and features hexagonal markings. The egg has a pair of filaments extending from its anterodosal side, which prevents it from sinking into soft substrates where it may be deposited. The penetration of spermatozoa into the egg takes place through a small opening located in the conical protrusion at the anterior end. As the egg moves through the uterus, multiple sperm may enter it, but normally only one is involved in fertilization. The spermatozoa have been stored by the female since the time of mating. Right after the sperm enters , the meiotic divisions are finalized and the egg nucleus is established.

The sperm and egg nuclei allign next to each other to create the zygote nucleus, which divides into the first two cleavage nuclei, marking the embryo's initial development stage. The mother may lay eggs soon after sperm perpetration or keep them in the uterus during early development (Demerec and Kaufman, 1996).

Larval Stage

The larval phase comprises three instars, collectively lasting approximately four days. By this stage, most cell types are already differentiated and functional, enabling numerous biological investigations to be conducted at the larval level. For example, larvae have been instrumental in neurobiological research, including studies on memory formation. The larval central nervous system is composed of about 10,000 neurons, providing a simpler model compared to the more than 250,000 neurons in the adult fly (Widdman *et al .,* 2017). Transitions between larval instars are marked by molting events [Lewis *et al .,* 2015). The larvae feed with such intensity and activity that the medium that they are crawling in becomes

extensively channeled and furrowed (Demereck and Kaufman, 1996). The larva comprises 12 segments, 3 head segments, 3 thoracic segments and 8 abdominal segments. The body walk, which is soft and flexible , is made up of an outer non cellular cuticula and an inner cellular epidermis. A large number of sense organs are distributed uniformly across the entire body.The circulatory organ of the larva is the dorsal blood vessel . The muscles in the liver, which are arranged in segments and transparent , can be made visible by fixing the larva in hot water. According to Kumar (2014) ,the larva contains several primitive cell complexes known as imaginal discs which serve as the precursors for future imaginal structures.

Pupal Stage

The process through which the insect transitions from larva to adult form consisting of a sequence of developmental stages, is termed “Metamorphosis”. During the pupal stage the most severe stages occurs in this process of transformation. The pupal stage commences following encapsulation of the third-instar larva and lasts for approximately four days. During this period, many larval structures undergo histolysis, while adult structures develop from imaginal discs, which originate from undifferentiated larval cells. These discs give rise to adult features such as the head, legs, wings, thorax, and reproductive organs. Certain larval structures, including the nervous system and gonads, are maintained throughout the pupal stage .

Adult Stage

The adult fly emerges upon eclosion from the pupal case. The average lifespan is around 30 days, although this can vary depending on environmental conditions such as temperature. Their wings are not fully extended, and they are pale in color and delicate . In few hours, these flies darken and resemble adult flies in appearance (William, 2000). Each female is capable of laying up to 100 eggs per day, resulting in large progeny numbers following

genetic crosses. These characteristics, coupled with ease of laboratory maintenance, underscore Drosophila melanogaster as a highly effective genetic model organism.

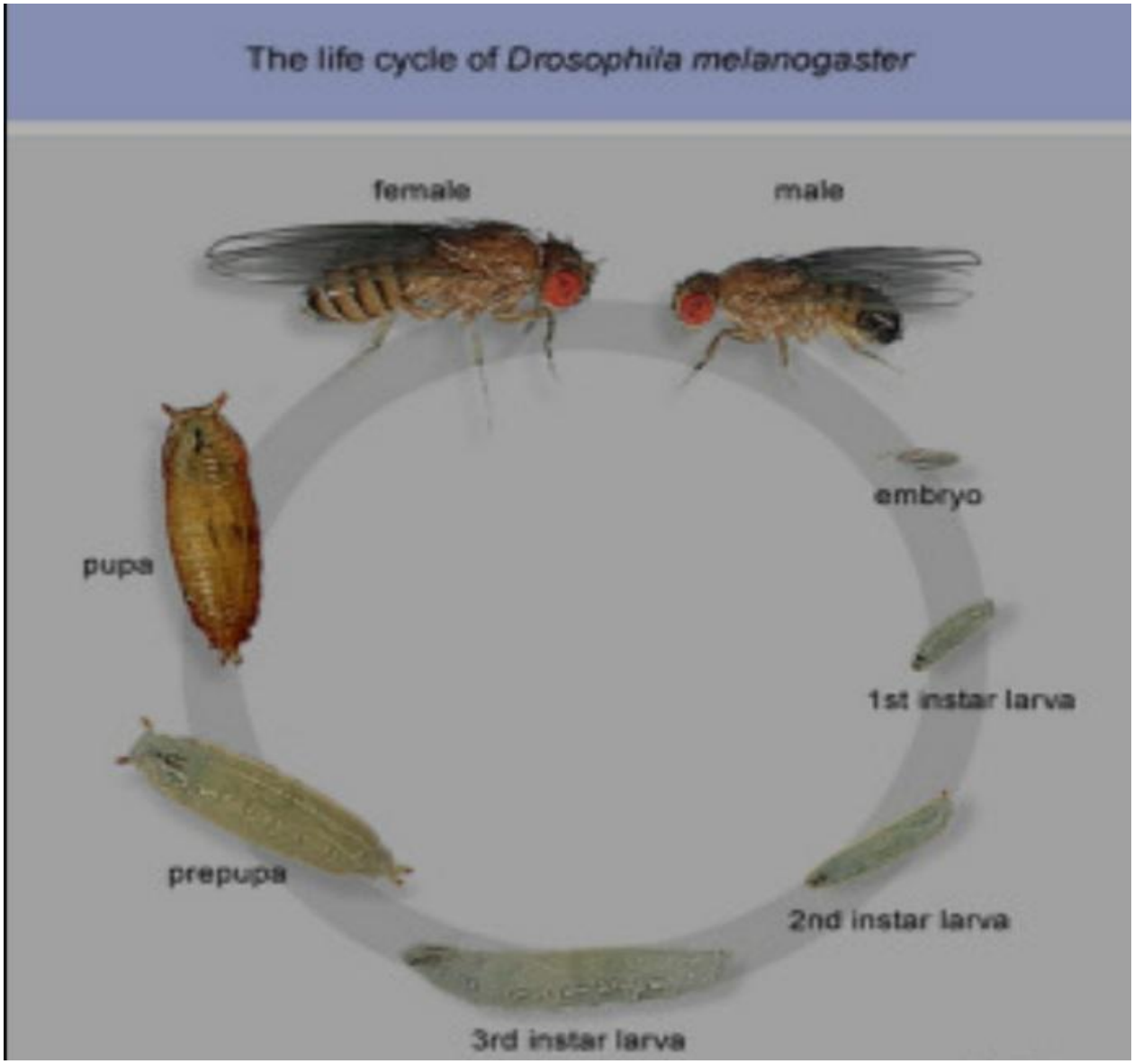

Figure 2.1: Showing the diagram of the Life cycle of Drosophila melanogaster (Widmann *et al* .,2018)

2.2.2 Fly structure (anatomy)

Key Anatomical Structures of Drosophila melanogaster include:-

Compound Eye

The compound eye is composed of thousands of specialized cells, each with distinct roles ranging from photoreception to non-neuronal support functions. Extensive research on patterning, morphogenesis, and intercellular communication has provided significant insights into both the development and function of the Drosophila eye (Cagan, 2009).

Antennae

The antennae represent paired sensory structures located on the head of the fly. Within the second antennal segment lies the Johnston's organ, a mechanosensory structure that functions as the hearing organ of Drosophila. This organ detects diverse stimuli, including acoustic signals (e.g., during courtship), wind, and gravity. Sensory input from the antennae is transmitted to the brain, enabling appropriate behavioral responses (Matsuo and Kamikouchi , 2013).

Proboscis

The proboscis plays a central role in detecting non-volatile compounds. It is involved in feeding, identification of toxic substances, recognition of non-volatile pheromones during mating, and selection of oviposition sites. Importantly, gustatory receptors are not confined to the mouthparts but are distributed throughout the fly's body within hairlike sensilla. Numerous studies have investigated these receptors in the context of gustation and chemosensory signaling (Montell , 2009)

Bristles

Bristles are mechanosensory organs forming part of the peripheral nervous system. They are distributed across the surface of the adult fly and are composed of four specialized cells, including a sensory neuron. Bristle development occurs during the late larval and early pupal

stages, originating from a single sensory organ precursor (SOP) cell. Owing to their defined lineage, bristles serve as a valuable model for studying asymmetric cell division and cellular differentiation (Furman and Bukharina , 2011)

Ovaries

In adult females, the ovaries represent the largest internal organs, each containing approximately 18 ovarioles where eggs are produced. Oogenesis, which lasts about one week, is the process by which mature oocytes arise from stem cells within the germarium. This process begins with the budding of egg chambers (follicles) and concludes with the formation of a mature oocyte. Each egg chamber comprises both somatic and germline cells, ultimately giving rise to a single egg. Oogenesis requires coordinated asymmetric cell division, fate determination, and cell migration (Bastock and St Johnson, 2008).

2.2.3. Importance of Drosophila melanogaster In Research

From the very beginning, the advantages of breeding fruit flies in captivity were evident and others were added over time (Perveen, F.K 2018 ,Yamaguchu, M *et al).*

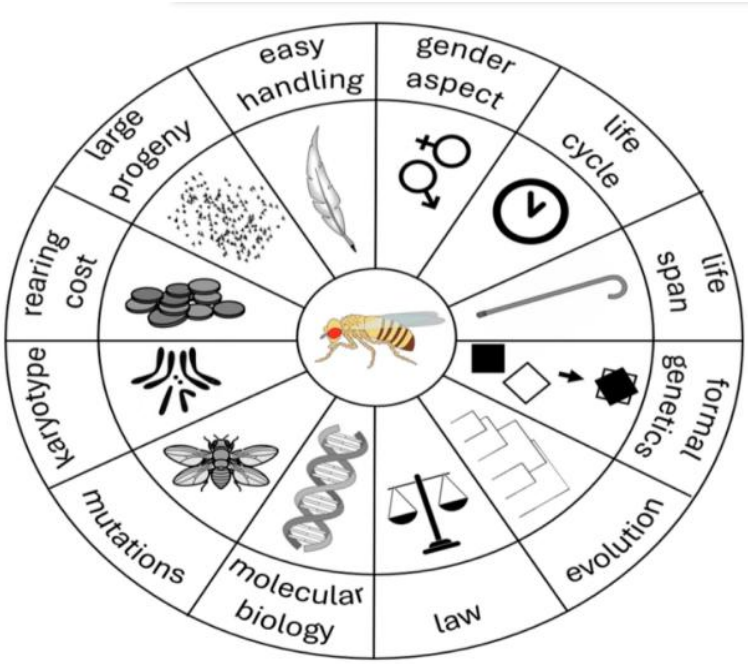

Figure 2.2: An image showing the importance of Drosophila melanogaster

Short Lifespan and High Reproductive Rate

One of the greatest strengths of Drosophila is its rapid life cycle. An embryo forms just 24 hours after fertilization, progressing through three larval stages before becoming an adult in as little as 10 days. This fast turnover allows researchers to produce large numbers of flies in a short time.

High Reproductive Rate

It enables large sample sizes.A single female can lay up to 1,500 eggs during her lifetime, ensuring a continuous supply of test subjects for genetic experiments(News Medical,2025).

Minimal Maintenance Requirements

Their small size and simple living needs make Drosophila easy and inexpensive to keep in the lab. Even laboratories with limited space, equipment, or funding can maintain and study large populations of these flies without difficulty.

Genetic Simplicity and Similarity to Humans

Genetically, Drosophila offers an excellent balance between simplicity and relevance. With only four pairs of chromosomes (compared to the 23 pairs in humans), their genes can be mapped and studied more easily. The entire genome has been sequenced and annotated, and although it is much smaller than the human genome about 5% of its size roughly 60% of fruit fly genes are similar to ours due to a shared evolutionary ancestor. Many of these shared genes are linked to diseases such as cancer, making Drosophila valuable in studying inheritance patterns and disease mechanisms.

Clear Anatomical and Behavioral Markers

Fruit flies have easily observable traits, such as wing shape and eye color, which can be examined under a microscope. Interestingly, they also share certain behaviors with humans including eating, mating, and sleeping which allows scientists to explore how genetics might influence behavior(News Medical,2025).

In Toxicology and Antioxidant Research

Oxidative Stress Research: When organisms are exposed to harmful substances, there is often an increase in biological markers such as superoxide dismutase (SOD), catalase (CAT), and malondialdehyde (MDA), which signal cellular stress.

- Antioxidant Evaluation: Natural compounds, including hesperetin and vitamin E, have demonstrated protective roles by reducing oxidative damage in Drosophila.
- Survival Studies: Drosophila serves as a valuable model for examining lifespan and survival outcomes under different dietary conditions or chemical treatments.

In addition to its role in neurological research, Drosophila melanogaster has been widely applied in studies of cancer, cardiovascular function, and metabolic disorders. Research on tumor suppressor genes, including scribbled and discs large, has advanced understanding of cell polarity and mechanisms underlying tumor development (Bier, 2005). Likewise, the fruit fly has been instrumental in investigating insulin signaling and pathways associated with obesity, highlighting its significance as a model for exploring metabolic syndromes (Pandey and Nichols, 2011).

Drosophila melanogaster has been a favorite in biomedical research for over a century and for good reason. It's small, cheap to maintain, reproduces quickly, and offers powerful genetic tools that makes it ideal for studying biological processes. As science has evolved, so have the tools used with Drosophila, allowing researchers to stay on top of the latest advancements in molecular biology.

In recent times, scientists have continued to rely on fruit flies to explore a wide range of topics from understanding human diseases and cell development to studying behavior and the aging process. These tiny creatures continue to play a big role in shaping research in other biological models.

2.3 History of Knorr chicken seasoning

Knorr has been a pioneer in authentic flavor since 1838, with a legacy as rich as its taste. Founded by Carl Heinrich Theodor Knorr, the brand began as a modest general store dealing in food and spices before evolving into a spice factory that paved the way for its global expansion. By 1901, Knorr had introduced a diverse range of soup tablets, and by 1911, it operated the largest macaroni factory in Europe. A major breakthrough came with the launch of bouillon cubes, which revolutionized cooking by making concentrated stock convenient and widely available to households everywhere (Dean, 2025).

2.4 Composition and bioactive components of knorr chicken seasoning

The idea of seasoning cubes actually started in Europe in the early 1900s. A Swiss businessman named Julius Maggi created the first bouillon cube in 1908, giving families a simple way to boost the flavor of their food without having to make homemade stock from scratch (Anaekwe , 2025). Seasoning cubes are those small, handy blocks packed with flavor that many of us add to bring our meals to life. Made from a mix of salt, spices, herbs, and sometimes meat or vegetable extracts, they're a go-to in kitchens all over the world. Because they dissolve so easily in water, they make cooking things like soups, stews, and sauces quicker and more convenient without sacrificing taste.

Over the years, seasoning cubes have become a global kitchen essential. Popular brands like Knorr and others have expanded their product lines to suit different regional flavors and preferences. By the mid-1900s, these cubes had made their way into homes across Africa especially in Nigeria where they were warmly welcomed for their ability to enhance the taste of beloved local dishes.

Today, seasoning cubes come in many varieties, designed to suit different cooking styles and dietary needs. Knorr chicken is a complex blend designed to enhance savory flavor. Its major constituent include:

Salt (NaCl): Primary taste enhancer;can influence osmotic balance.

Monosodium glutamate(MSG):Umami agent; modulates neurotransmission and metabolism.

-May increase appetite and digestive enzyme secretion.

Dehydrayed chicken stock and natural flavors:Sources of peptides and nucleotides with potential antioxidant .

Hydrolyzed vegetable oil:Rich in free amino acids and small peptides.

Yeast Extract:

-Contains nucleotides like inosine monophosphate (IMP) and guanosine monophosphate(GMP).

-These compounds amplify umami and may support gut health

Spices and herbs:Onion, garlic, paprika known to contain polyphenols and sulfur containing antioxidants.

Component	Function
Salt	Preserves and boost base flavor
Fats	Adds richness and mouthfeel
Flavor enhancers	Amplify umami taste
Yeast enhancers	Enhances savory depth
Spices	Provide aroma,color,and subtle nutrition
Chicken powder	Add meat like taste
Sugar,caramel	Balance flavor and appearance
High sodium content	Intensifies taste

Table 2.1. A table showing the functional roles of knorr chicken seasoning cube.

2.5.1 Dietary Additives and Survival Rate In Drosophila melanogaster

Diet plays a major role in shaping the lifespan, reproductive capacity, and overall health of Drosophila melanogaster. Thanks to its short lifespan and well-understood biology, the fruit fly is an excellent model for studying how different dietary factors can influence survival rates.

1. Nutrient Composition and Longevity

The type and balance of nutrients in a fly's diet directly affect how long it lives. Diets high in carbohydrates can provide quick bursts of energy but may shorten lifespan if consumed in excess. On the other hand, an adequate amount of protein is essential for reproduction and tissue repair (Lee *et al*., 2008). One key factor is the protein-to-carbohydrate (P:C) ratio. Research shows that flies fed an optimal P:C ratio of 1:4 tend to live longer than those given protein-heavy diets (Simpson and Raubenheimer, 2009).

2. Dietary Additives and Bioactive Compounds

Certain dietary additives and bioactive compounds can also influence survival rates. Antioxidants such as glutathione help combat oxidative stress, which is a key factor in aging. For example, plant-based polyphenols like resveratrol have been shown to increase both the median and maximum lifespan of flies. Similarly, natural antioxidant enzymes such as superoxide dismutase (SOD), catalase, and glutathione peroxidase protect cells by neutralizing harmful free radicals, promoting better cellular health and longevity.

2.5.2 Effect of salt and other additives on the survival rate of drosophila melanogaster

High dietary salt has been shown to shorten lifespan and impair stress tolerance in drosophila by disrupting ionic homeostasis.

Dietary additives such as flavor enhancers, salts, and plant extracts—are common in processed foods like Knorr seasoning cubes. Although intended to improve taste and shelf life, some of these substances can significantly affect health and longevity. Drosophila

melanogaster provides an ideal model for exploring these effects due to its short lifespan and well-characterized genetics (Pandey and Nichols, 2011).

Monosodium Glutamate (MSG)

Long-term exposure: MSG added to the diet of fruit flies leads to a lifespan reduction of up to ~23%. While brief exposure seems to stimulate antioxidant mechanisms, continued consumption elevates reactive oxygen and nitrogen species, causing oxidative stress and decline in survival (Oyeyinka *et al*., 2017).

Low-dose exposure: In contrast, very low dietary MSG levels (≤ 0.2%) appear benign, with no noticeable impact on survival, mobility, or hydrogen peroxide clearing capacity (Kasozi *et al*., 2018)

High-Salt Diets

- One study found that older flies fed a 1% NaCl diet survived just ~2 days, compared to 8–10 days on a normal diet.
- Another experiment showed that flies given sucrose with 500 mM NaCl—produced survival kinetics nearly identical to complete starvation.
- Additionally, flies consuming food containing more than 5% NaCl exhibited drastically reduced survival, comparable to unfed/starvation conditions
- Research on fruit flies has provided critical insights into how common food components, such as sweeteners, preservatives, and natural antioxidants, influence survival and aging.

Artificial Sweeteners and Sugars

Excess sugar consumption in Drosophila is strongly associated with obesity-like symptoms, insulin resistance, and reduced longevity. Flies reared on sugar-rich diets show disrupted energy balance and impaired insulin/insulin-like growth factor signaling, a pathway closely tied to aging and metabolic health (Musselmanl *et al*., 2011; Partridge, Alic, Bjedov, and

Piper, 2011). Similarly, certain artificial sweeteners alter metabolic regulation in ways that mirror the effects of high dietary sugar, suggesting that chronic exposure to these additives can compromise both metabolism and survival.

Preservatives and Synthetic Additives

The use of chemical preservatives in food raises concerns about long-term safety, and Drosophila studies highlight potential risks. Compounds such as sodium benzoate and parabens have been shown to shorten lifespan, delay development, and reduce fertility in flies (Rand, Kearney, Dao, and Clason, 2010). These negative effects are thought to arise from oxidative stress and mitochondrial dysfunction, indicating that prolonged intake of some synthetic additives may compromise cellular integrity and organismal survival.

Antioxidants and Phytochemicals

Unlike synthetic additives, natural compounds rich in antioxidants often enhance longevity in Drosophila. Polyphenols and flavonoids derived from fruits and vegetables have been reported to reduce oxidative damage, improve stress resistance, and extend lifespan. For example, apple polyphenol supplementation not only prolonged fly survival but also improved physical performance during aging (Peng *et al*,. 2011). Similarly, compounds such as resveratrol and green tea catechins act through conserved molecular pathways, including SIRT1 and AMPK, to mimic calorie restriction and promote healthy aging (Wood *et al*., 2004).

2.5.3 Influence of salt and Umamai agent

The sense of taste helps animals choose foods that provide nutrients while steering clear of substances that could be dangerous. Avoiding toxic or harmful compounds is vital for survival, and over time, most animals have developed highly advanced systems to detect these threats. In mammals, for instance, T2R taste receptors can recognize a wide variety of naturally occurring toxins (Chandrashekar *et a*l., 2000). Interestingly, there are far more T2R

receptors than those used to detect pleasant tastes like sweetness and umami (Behrens *et al*., 2007; Meyerhof *et al,* 2010). A similar pattern is seen in the fruit fly, Drosophila melanogaster, even though it is only distantly related to mammals.

Salts are ionic compounds made up of positively and negatively charged particles. They supply important micronutrients that the body needs to function properly. However, too much salt can be harmful. In mammals, excessive salt intake has been linked to health problems such as high blood pressure, osteoporosis, certain gastrointestinal cancers, and autoimmune disorders (Heaney, 2006; Jones et al., 1997; Luft *et al*., 1979; Sharif *et al*., 2018; Strazzullo *et al*., 2009; Wu *et al*., 2021). Similarly, studies have shown that consuming high levels of salt can also have negative effects on flies.

High dietary salt intake has been shown to cause multiple physiological impairments in Drosophila melanogaster, including reduced neuronal plasticity and neurotransmitter release, accelerated cardiac aging, and disrupted sleep patterns (Murashov *et al*., 2021; Naikkhwah and O'Donnell, 2011; Stergiopoulos *et al*., 2009; Xie *et al*., 2019). Given these adverse effects, it is reasonable to expect that chronic salt exposure may influence the lifespan of flies. Drosophila melanogaster are osmoregulators, capable of maintaining a stable internal osmolality despite fluctuations in environmental salt concentrations. While this allows them to tolerate high-salt diets, maintaining hemolymph osmolality under extreme conditions likely incurs significant energetic costs. Additionally, certain ionic species have been shown to disrupt normal physiological functions, with increased mortality observed in flies exposed to elevated sodium, calcium, or metal ions (Lee *et al*., 2017, 2018; Xiao *et al*., 2022).

To avoid excessive salt intake, the Drosophila gustatory system has evolved specialized gustatory receptor neurons (GRNs) that detect and deter high-salt ingestion. These include Gr66a bitter GRNs and Ppk23 high-salt GRNs (Jaeger et al., 2018; McDowell *et al*., 2022). Salt also inhibits the Ppk28 osmolality receptor, expressed in water-sensitive GRNs

(Cameron *et al*., 2010). The present study further demonstrates that high salt suppresses the activity of Gr64f sweet GRNs, which encode appetitive value.

Gr64f GRNs are known to be inhibited by a range of tastants, including organic acids (Charlu et al., 2013), bases (Clark *et al*., 2023), bitter compounds (French *et al*., 2015; Jeong *et al*., 2013), and metal ions (Xiao *et al*., 2022). Salt is unique in that it both inhibits and activates these neurons: low salt concentrations stimulate Gr64f GRNs and mediate attraction, whereas high concentrations reduce responsiveness. Electrophysiological data reveal a bimodal, concentration-dependent response, indicating strong attraction at low salt levels and diminished attraction at high levels.

The inhibitory effect of high salt on Gr64f GRNs appears selective, as it does not cause irreversible toxicity nor affect Gr66a GRNs in the same way. This suggests a targeted inhibitory mechanism rather than generalized neuronal suppression. The anionic component of the salt appears to play little role, as similar results were obtained with both chloride and sulfate salts of sodium. Instead, the cation type strongly influences inhibition, with a clear relationship between oxidation state and inhibitory strength: Fe^{3+} exhibited the greatest effect, followed by Mg^{2+} and Ca^{2+}, while Na^{+} and K^{+} had the weakest effects(Dey M., *et a*l,2023).

2.5.4 Role of Plant Derived Polyphenols

Phytochemicals are specialized plant metabolites stored in various tissues, including roots, stems, leaves, flowers, and fruits. They comprise a diverse range of compounds such as polyphenols, carotenoids, flavonoids, coumarins, terpenoids, glucosinolates, saponins, and capsaicinoids—many of which are responsible for the characteristic colors of fruits and vegetables. Although not essential nutrients for plants, these compounds contribute significantly to the health-promoting properties of plant-based diets. Documented biological activities of phytochemicals include antioxidant, anti-inflammatory, anticancer, and antimicrobial effects, making them promising candidates for the development of novel

pharmaceuticals and dietary supplements. Their beneficial, and in some cases adverse, effects are mediated through interactions with multiple cellular signaling pathways, though the precise molecular mechanisms remain an active area of research.

The fruit fly Drosophila melanogaster serves as an effective model organism for investigating the biological effects of phytochemicals, particularly due to its well-characterized central nervous system, which facilitates studies on sensory functions (olfaction, taste, hearing, vision) and motor behaviors (flight, locomotion, learning, and memory). Research has demonstrated Drosophila's utility in elucidating molecular pathways and aiding the development of phytochemical-based therapeutics for cancer, neurodegenerative diseases such as Alzheimer's and Parkinson's, and their associated genetic components.

Several practical advantages underpin the widespread use of Drosophila in biological research. These include its high reproductive rate (30–50 eggs per day), short generation time (approximately 10 days at 25 °C), low maintenance cost, and relatively short lifespan (about three months at 25 °C), which collectively enable efficient lifespan and longevity assays. Furthermore, the availability of powerful molecular and genetic tools permits targeted gene overexpression or silencing, thereby facilitating mechanistic studi

Despite its evolutionary distance from humans, Drosophila shares substantial physiological, biological, and metabolic similarities with mammals, including insulin signaling, nutrient sensing, and energy homeostasis pathways—key processes implicated in metabolic disorders such as diabetes and obesity. The ingestion of phytochemical-rich diets can also modulate the gut microbiome, which, by influencing host genomic, transcriptomic, epigenomic, proteomic, and metabolomic profiles, can alter both phenotype and behavior.

Owing to parallels between human and Drosophila disease mechanisms, coupled with its genetic tractability, the species is particularly well-suited as a primary model for examining the effects of phytochemicals in neurodegenerative conditions (e.g., Alzheimer's, Parkinson's,

Huntington's), cardiovascular diseases, muscular atrophy, aging, and metabolic disorders. In the context of plant-based drug discovery, Drosophila offers distinct advantages over cell-based assays by enabling whole-organism screening and the investigation of complex phenotypes. To date, it has been extensively employed in in vivo screening of plant-derived compounds with therapeutic potential, particularly in studies targeting age-related neurodegenerative and metabolic diseases, thereby advancing understanding of their mechanisms of action(Lopez-Ortiz *et al*., 2023)

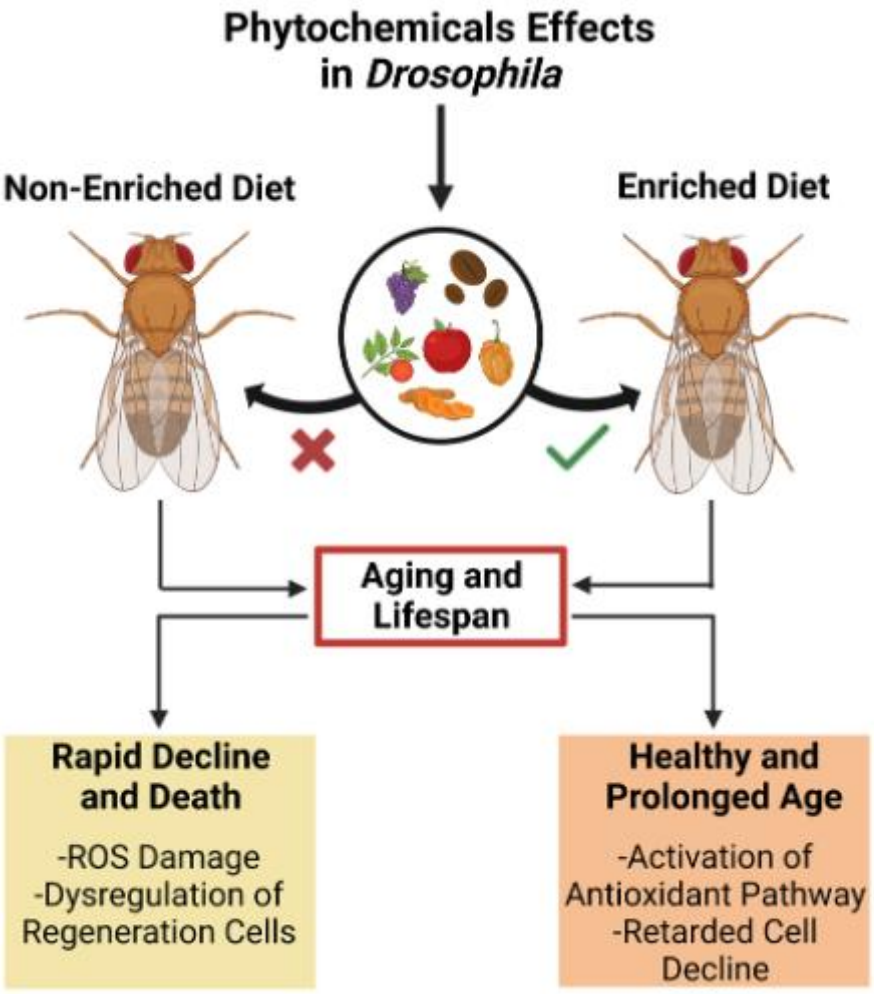

Figure 2.3 The impact of photochemical enriched diet on the lifespan of Drosophila melanogaster for promoting healthy living and longevity.

2.6 Drosophila in Toxicity and Antioxidant Research

Fruit flies (Drosophila melanogaster) have become a reliable model for studying how different substances affect the body—especially in areas like aging, fertility, enzyme function, and overall survival. Interestingly, their antioxidant defense system is quite similar to that of humans. According to Rand *et al*. (2010), they rely on key enzymes such as:

- Catalase (CAT)
- Superoxide dismutase (SOD)
- Glutathione peroxidase

Superoxide Dismutase (SOD)

Superoxide dismutases (SODs) are a family of metal-containing enzymes found across all forms of life. They play a crucial role in protecting the body against oxidative stress, serving as a key line of antioxidant defense. SODs are also considered valuable therapeutic agents in combating diseases caused by reactive oxygen species (ROS). However, their direct use in clinical settings faces certain challenges, leading researchers to develop SOD conjugates and mimetics to improve their therapeutic effectiveness.Superoxide radicals (O_2^-) into hydrogen peroxide (H_2O_2), thereby limiting oxidative stress. In Drosophila, it is present in two primary isoforms: SOD1, located in the cytosol, and SOD2, situated in the mitochondria. This enzyme plays a vital role in regulating lifespan and safeguarding neuronal function.

Beyond neutralizing ROS, SOD also has anti-inflammatory properties and can help prevent the transformation of normal cells into precancerous ones. Natural SOD levels decline with age, which increases vulnerability to oxidative stress-related disorders. SOD mimetics—synthetic compounds designed to replicate the activity of native SOD—convert superoxide radicals (O_2^-) into hydrogen peroxide (H_2O_2), which catalase then breaks down into harmless

water and oxygen. These mimetics are particularly attractive in therapy because they are smaller, have a longer half-life, and function similarly to the natural enzyme.

Glutathione peroxidase

Glutathione peroxidase is a powerful antioxidant enzyme that helps the body neutralize harmful free radicals.In doing so it protects cell membrane from damage ,prevents the breakdown of fats and keeps the cells internal environment and redox balance stable.

Catalase

Catalase is found in all organisms that use oxygen .It plays a vital role in protecting cells by quickly breaking down hydrogen peroxide into harmless water and oxygen,especially when the cells are under environmental stress.Catalase (CAT) is an antioxidant enzyme that decomposes hydrogen peroxide into water and oxygen ($2H_2O_2 \rightarrow 2H_2O + O_2$). It is primarily localized in peroxisomes and also found in the cytosol. By eliminating excess H_2O_2, CAT prevents its accumulation and protects cells from oxidative damage, including lipid peroxidation.

These enzymes play a vital role in protecting cells from oxidative stress—a harmful state where unstable molecules (free radicals) cause damage to the body. When fruit flies are exposed to certain food chemicals or additives, these enzymes can be either strengthened or weakened, ultimately affecting the fly's survival (Rzezniczak *et a*l., 2011).

Oxidative stress is a condition that arises when there's an imbalance between antioxidants and oxidants (such as free radicals or other reactive molecules) in the body, with oxidants outweighing the antioxidants.Oxidative or nitrosative stress occurs when the body produces more reactive oxygen species (ROS) and reactive nitrogen species (RNS) than it can neutralize.

The term ROS refers to a broad group of oxidants, which may be free radicals themselves or molecules capable of producing free radicals. These reactive particles—whether oxygen-based (ROS) or nitrogen-based (RNS)—are highly reactive but have short lifespans. They are naturally generated during normal cellular metabolism and also as a result of exposure to ionizing radiation.

In general, the various reactive molecules involved in oxidative stress are collectively called free radicals. A free radical is any chemical species that can exist independently and contains one or more unpaired electrons, making it highly reactive.

For instance, research involving fruit flies exposed to substances like heavy metals, food preservatives, or artificial colorants showed noticeable changes in enzyme activity and lifespan. Based on findings like these, it makes sense to use Drosophila to investigate whether everyday products like Knorr chicken seasoning , which contain additives such as monosodium glutamate (MSG) and salt, might have similar effects on antioxidant function and overall health.

2.6.1 Dietary modulation of Antioxidant status

Nutrient gene interaction

Nutrient–gene interactions refer to the way dietary components shape gene activity, metabolic processes, and overall physiological outcomes. In Drosophila melanogaster, nutrients such as sugars, amino acids, fats, and salts influence well-conserved signaling networks, including the Insulin/IGF signaling (IIS) pathway, Target of Rapamycin (TOR), Forkhead box O (dFOXO), and autophagy-related mechanisms. Through these pathways, diet can regulate growth, energy balance, stress tolerance, aging, and even lifespan (Reddiex *et al*., 2018; Dietary Restriction Review, 2013)

Nutrient–Gene Interactions in Relation to Knorr Seasoning Constituents

Nutrient–gene interactions describe how specific dietary components influence genetic pathways, thereby regulating metabolism, physiology, and overall health. Knorr seasoning cubes, commonly used as flavor enhancers in culinary practices, are composed of bioactive nutrients such as flavonoids (from plant extracts), glutamate, lipids, amino acids, sodium/salt, and small amounts of micronutrients. These components act not only as flavoring agents but also as molecular signals capable of interacting with conserved genetic pathways in organisms such as Drosophila melanogaster. Because the fruit fly shares many homologous genes with humans, it provides an ideal model for understanding how these constituents may modulate signaling pathways and physiological outcomes (Piper and Partridge, 2018).

Flavonoids and Antioxidant Gene Regulation

Flavonoids, which are often incorporated into Knorr seasoning through dehydrated vegetables and herbs, are potent phytochemicals with antioxidant properties. In Drosophila, flavonoids can activate endogenous antioxidant defense systems, including genes encoding superoxide dismutase (SOD), catalase (CAT), and glutathione S-transferases (GST). These enzymes protect cells against oxidative stress by neutralizing reactive oxygen species (ROS), thereby reducing cellular damage and aging (Surai, 2014). Flavonoid-mediated upregulation of transcription factors such as dFOXO also enhances stress resistance, promotes autophagy, and is linked to extended lifespan in flies (Greer and Brunet, 2008).

Glutamate and Neurotransmission Pathways

Monosodium glutamate (MSG), a major component of Knorr cubes, serves as a flavor enhancer but also functions as a critical neurotransmitter. In Drosophila, glutamate signaling influences synaptic plasticity, memory, and locomotor activity (Parmentier *et al.*, 2016). However, excess dietary glutamate has been linked to neurotoxicity through overactivation of glutamate receptors, leading to oxidative stress and altered expression of stress-related genes.

Glutamate availability also affects metabolic genes, given its role as a nitrogen donor in amino acid synthesis.

Sodium and Salt-Sensing Genes

Knorr cubes contain significant amounts of sodium chloride (NaCl), which interacts with salt-sensing mechanisms in Drosophila. Sodium is essential for maintaining osmotic balance and nerve conduction, but excessive intake may upregulate genes associated with osmotic stress and hypertension-like phenotypes (Zhang *et al*., 2013). Studies in flies show that high-salt diets activate stress-response pathways, including those regulated by MAPK signaling, and impair cardiac and renal function (Na *et al*., 2013). Thus, dietary salt not only modulates taste-related genes but also has systemic effects on longevity and stress tolerance.

Lipids and Energy-Related Pathways

Lipids, present in Knorr cubes through vegetable oils and fat-based carriers, provide essential fatty acids that act as both energy sources and signaling molecules. In Drosophila, lipids regulate nuclear hormone receptors such as Ecdysone receptor (EcR) and influence metabolic pathways controlled by the Target of Rapamycin (TOR). Diets rich in lipids have been shown to activate lipogenesis genes, leading to fat accumulation and obesity-like phenotypes in flies (Musselman *et al*., 2011). Conversely, moderate lipid intake supports membrane synthesis, hormone regulation, and normal reproductive gene expression.

Amino Acids and Growth Pathways

Knorr cubes contain amino acids either directly or as hydrolyzed protein components. Amino acids are key regulators of the Insulin/IGF signaling (IIS) pathway and the TOR pathway, both of which control cell growth, protein synthesis, and lifespan. In Drosophila, amino acid deprivation downregulates TOR activity, activating autophagy and stress-response genes, which contributes to extended lifespan (Kapahi *et al*., 2010). However, excessive amino acid

signaling can promote accelerated growth but shorten lifespan, demonstrating the importance of balanced intake.

Implications of Nutrient–Gene Interactions

The constituents of Knorr seasoning cubes therefore represent more than flavoring agents; they are nutritional signals that can modulate gene activity. Flavonoids enhance antioxidant defenses, glutamate affects neuronal and metabolic genes, sodium influences osmotic and stress pathways, lipids regulate energy balance, and amino acids drive growth-related signaling. These nutrient–gene interactions can result in significant changes in growth, metabolism, stress resistance, aging, and lifespan in Drosophila melanogaster, making it an excellent model for studying both the beneficial and adverse effects of seasoning cube consumption.

2.6.2 Impact of Knorr chicken on Lifespan and Healthspan In Drosophila melanogaster

Knorr seasoning cubes are widely used culinary additives that contain a mixture of ingredients such as salt, monosodium glutamate (MSG), starch, vegetable oils, yeast extract, flavor nucleotides, citric acid, and various spices (Unilever, n.d.). Although primarily consumed for flavor enhancement, these constituents have been shown to influence biological systems, including nutrient-sensing pathways, oxidative stress responses, and metabolic regulation. In Drosophila melanogaster, which serves as a reliable model for studying diet–health interactions, these components can directly or indirectly affect both lifespan and healthspan.

Salt (NaCl)

Salt is one of the major components of seasoning cubes. Studies in Drosophila have demonstrated that diets rich in salt reduce lifespan and impair physical performance. High salt intake increases oxidative stress and accelerates age-related functional decline, particularly affecting climbing ability, which is a common marker of fly healthspan. However, protective

effects such as endurance exercise can help counteract some of these adverse effects (Zhang *et al*., 2020).

Monosodium Glutamate (MSG)

MSG is another key ingredient, primarily used as a flavor enhancer. Research indicates that prolonged consumption of MSG shortens lifespan in flies, mainly by elevating oxidative and nitrosative stress levels. While short-term exposure may stimulate antioxidant responses, chronic intake overwhelms the system, leading to progressive decline and reduced survival (Oyeyinka *et al.*, 207).

Sugars and Starch

Carbohydrates such as starch are metabolized into sugars, which in high amounts can disrupt insulin signaling pathways in Drosophila. Excessive sugar consumption results in obesity-like symptoms, insulin resistance, fat accumulation, and activation of stress pathways such as FOXO. These metabolic disturbances not only compromise healthspan but also shorten lifespan significantly (Musselman *et al*., 2011).

Fats and Oils

Dietary fats, when present in large amounts, interact with sugars to worsen metabolic dysfunction. In flies, such diets lead to increased lipid storage, reduced locomotor activity, and shortened survival. This suggests that excess oils in seasonings, when consumed consistently, may negatively affect longevity (Musselman *et al*., 2011*).*

Pro-oxidant and Antioxidant Status

Within living cells, reactive oxygen species (ROS) are continuously generated during normal metabolism as well as in response to external factors such as pollutants, toxins, and diet. The extent to which an organism experiences oxidative stress depends on the balance between pro-oxidant activity and antioxidant defenses (Valko *et al*., 2007).

Pro-oxidant status refers to conditions that increase the production of ROS or other reactive species. When present in excess, these molecules can damage important cellular components such as DNA, proteins, and lipids. This imbalance contributes to aging and the onset of chronic diseases. Examples of dietary and environmental factors that promote a pro-oxidant state include:

- High salt intake, which has been shown to increase oxidative stress and reduce lifespan in Drosophila melanogaster (Zhang *et al*., 2020).
- Monosodium glutamate (MSG), a common food additive, which can trigger lipid peroxidation and reduce survival (Oyeyinka *et al.*, 2017).
- High sugar diets, which disrupt metabolism, cause insulin resistance, and elevate ROS levels (Musselman *et al*., 2011).
- Exposure to environmental toxins, such as pesticides and pollutants, which overwhelm cellular defense systems.

Antioxidant status, on the other hand, represents the body's ability to neutralize ROS and maintain redox balance. Antioxidants prevent oxidative damage and support healthy aging. They can be classified into:

- Endogenous antioxidants like superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx), which detoxify harmful radicals inside cells.
- Exogenous antioxidants obtained from food sources, such as vitamins (C and E), flavonoids, polyphenols, and carotenoids. In Drosophila, natural compounds such as green tea and apple polyphenols have been shown to boost antioxidant defense and extend lifespan (Li *et al*., 2007; Peng *et al*., 2011).
- Adaptive antioxidant responses, where mild stress (e.g., dietary restriction) can trigger hormesis, stimulating stronger antioxidant defenses and improving resilience (Fontana and Partridge, 2015).

The dynamic balance between pro-oxidants and antioxidants is therefore crucial. When ROS production outweighs antioxidant capacity, oxidative stress occurs, leading to cellular damage, reduced stress tolerance, and shorter lifespan. Conversely, when antioxidant defenses are strong, they protect cells and promote healthspan and longevity.

In relation to Knorr seasoning, ingredients such as salt, MSG, and sugars may enhance pro-oxidant activity, while the herbal spices and flavonoid content may contribute to antioxidant protection. This interplay ultimately determines whether the seasoning exerts a protective or harmful effect depending on dosage and frequency of consumption.

CHAPTER THREE

MATERIALS AND METHOD

3.1 Area of study

The study was conducted at the University of Benin ,located in Benin City, Edo State, Nigeria. University of Benin is a renowned public research university and a top tier institution for tertiary education in Nigeria.

3.2 Study Location

The study was conducted in a specialized laboratory facility -BIOTOXCS Research Laboratory. This specialized laboratory was furnished with the essential equipment required for the rearing and handling of Drosophila melanogaster. The controlled environment provided suitable conditions for the flies and supported the experimental procedures.

3.2.1 Inclusion Criteria

Adult Male and female Drosophila melanogaster less than 17 days of life.

3.2.2 Exclusion Criteria

Adult male and female Drosophila melanogaster above 17 days of life and immature stages of the flies.

3.3 Experimental Design

To estimate the concentration of knorr chicken seasoning in the Fruit flies(Drosophila melanogaster), this study used a randomized controlled trial design in which flies 35 flies specifically a day old were randomly selected to five treatment group , each of which was exposed to varying concentrations of Knorr chicken seasoning dilution. A control group, which consisted of flies not exposed to the extract was included for comparism. Random flies were selected from vials a day old and rendered immobile by chilling them in a fridge for five minutes at 4 degree celcius in a freezer. Using an ice pack, It was carefully handled with a soft bristled brush to lesson tension while counting.

Each treatment group of flies were reared and maintained under the same environmental condition , temperature , humidity , and illumination , to guarantee consistency. Moreover, a uniform exposure period to the extract was maintained across all treatment groups to guarantee reliable and comparable outcomes.

3.3.1 Dilution of Knorr chicken seasoning

Flies were collected and separated into 5 groups stated below in the experimental design

Group A: the control group which received 9.8g of cornmeal diet and 200μl of distilled water

Group B: received 9.8g of cornmeal and 200μl of 0.3g c dilution

Group C : received 9.8g of cornmeal and 200μl of 0.15 Knorr Chicken dilution

Group D: received 9.8g of cornmeal and 200μl of 0.1g Knorr Chicken dilution

Group E: received 9.8g of cornmeal and 200μl of 0.05 Knorr Chicken dilution

For each group there were three replicates containing 35 Flies in each vial.

Table 3.1 : Experimental grouping

Control A	200μl of distilled water + 9.8g of meal
Control B	200μl of distilled water + 9.8g of meal
Control C	200μl of distilled water + 9.8g of meal
Group 1(A)	200μl of 0.05(Knorr chicken seasoning) +9.8g of meal
Group 1(B)	200μu of 0.05(Knorr chicken seasoning)) +9.8g of meal
Group 1(C)	200μl of 0.05(Knorr chicken seasoning)) +9.8g of meal
Group 2(A)	200μl of 0.1(Knorr chicken seasoning)+ 9.8g of meal
Group 2(B)	200μl of 0.1(Knorr chicken seasoning))+ 9.8g of meal
Group 2(C)	200μl of 0.1(Knorr chicken seasoning)+ 9.8g of meal
Group 3(A)	200μl of 0.15(Knorr chicken seasoning))+ 9.8g of meal
Group 3(B)	200μl of of 0.15(Knorr chicken seasoning)+ 9.8g of meal
Group 3(C)	200μl of 0.15(Knorr chicken seasoning))+ 9.8g of meal
Group 4(A)	200μl of 0.3(Knorr chicken seasoning)+ 9.8g of meal
Group 4(B)	200μl of 0.3(Knorr chicken seasoning)+ 9.8g of meal
Group 4(C)	200μl of 0.3(Knorr chicken seas0ning)+ 9.8g of meal

3.3.2 Meal Preparation

850ml of water was measured using a measuring cylinder after which 150ml of water was taken to mix the cornmeal. 500ml of the water was boiled using a bunsen burner and some of the boiled water was added to the yeast,after which the agar was added to the boiling water and stirred for 10 minutes, cornmeal was then stirred and added simultaneously for 10 minutes after which the disolved yeast was added and simultaneously stirred for 15 to 20 minutes, glucose was then added and stirred till the meal becomes a little solid. It is then brought down and allowed to cool, then finally a nipargin solution is added to the meal .

After a few minutes, the meal was transferred into clear containers. The same instruction were followed for half standard meal with the appropriate measurement of ingredients as provided in table 3.2

Table 3.2 Meal Preparation

INGREDIENTS	STANDARD	HALF MEAL (9g)
Corn Meal	52	26g
Agar	7.9	3.95g
Ethanol	1-2ml	0.5ml
Glucose	3.5g	1.75g
Yeast	5g	2.5g
Nipargin	1g	O.5g
Water	850ml	425ml

3.3.3 Breeding

The prepared meals was poured into glass jars to cool down and solidify. These flies were carefully transferred into these jars containing the meals and covered with foam that was sized to fit the jar openings perfectly. Polyurethane foam is used in order to allow aeration in the jar, and after few days (8-10) the flies should have reproduced.

Thirty five flies were transferred into all the tubes (15) containing feed and treatment and covered with cotton wool , this setup was left for five days.

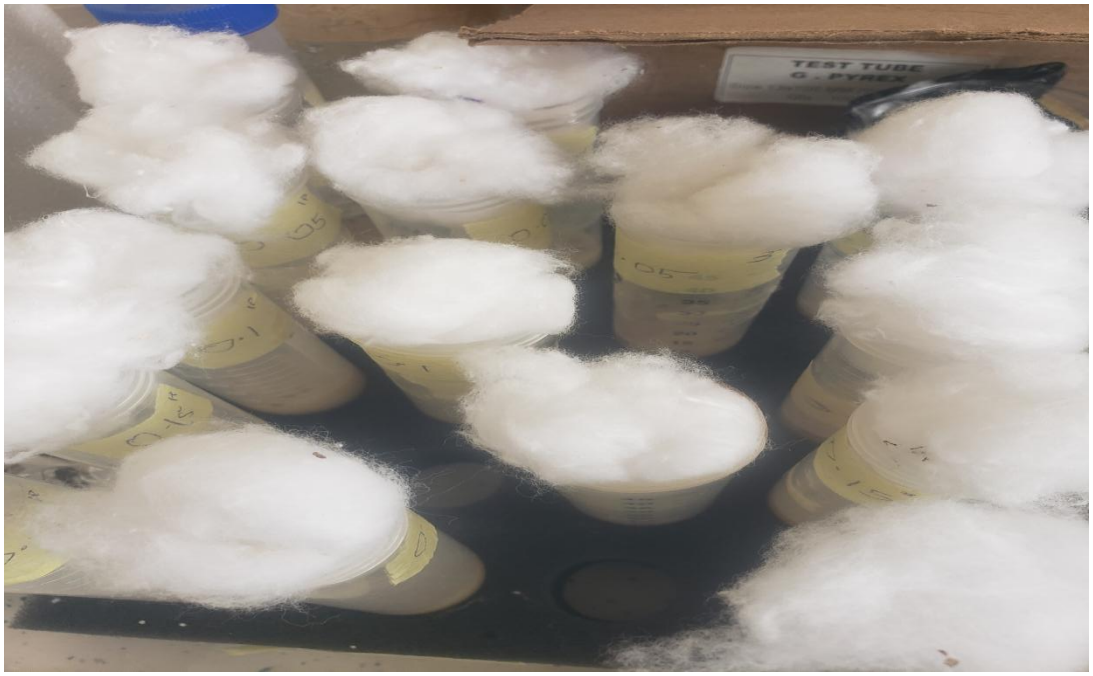

Figure 3.1: Showing the treatment process In the Laboratory

3.4 MATERIALS

3.4.1 CHEMICALS AND REAGENTS

Distilled water, Phosphate buffer, Hydrogen peroxide, Pottasium permanganate, Hydrogen chloride, Sulphuric acid.

3.4.2 Equipment

Major eqipment used includes: Bunsen burner, HISENSE refridgerator, HALER THERMOCOOL CHEST FREEZERS, Spectrophotometer, Centrifuge, Eppendorf tube, Test tubes, Automated pipettes,

3.5 Homogenization and Extraction of Supernatant

After 14 days of exposing the flies to different concentration of meal containing Knorr Maggi , the flies were transferred into empty vials with appropriate labels corresponding to the experimental group and were anaesthesized in a freezer for five minutes or less. Then, empty eppendorf tube were labelled according to concentration and weighed using a weighing balance to ascertain its weight after which flies were transferred into the eppendorf tube and weighed again to ascertain the weight of the tube and flies together in each group. After calculating the exact weight of flies, the flies were crushed inside the eppendorf tubes, then phosphate buffer was added in microlitres at a proportion of ten times the calculated weight of flies in milligram.

The eppendorf tube were tightly closed and spun in a centrifuge at 3500rpm for 5 minutes. Then the supernatant was extracted using a micro pipette into labeled eppendorf tubes and stored in a freezer before analysis.

3.6 Antioxidant level

3.6.1 Determination Of Catalase Activity

Catalase (CAT) activity was estimated by the method described by Cohen *et al.,* (1970).

3.6.2 Reagents used

Hydrogen peroxidase(H_2O_2)

Sulphuric acid(H_2SO_4)

Potassium permanganate($KMNO_4$)

3.6.2 Reagent preparation

0.1M $KMnO_4$ was prepared by distilling 0.158g of $KMnO_4$ in 100ml of distilled water. Phosphate buffer (pH 7.4) 0.426g of $NaHPO_4$ and 0.240g of NaH_2PO_4 were weighed and mixed together in 100ml of distilled water. 6M H_2SO_4 and 32.3ml of concentrated H_2SO_4 were mixed to 66.7ml of distilled water.

3.6.3 Procedure

Sample homogenate (0.25mL) was placed in ice – cold test tubes, the blank contained 0.25mL distilled water. Cold phosphate-buffered H2O2 (30 mM, 0.25 mL) was added to both blank and sample tubes at fixed intervals, and were mixed by inversion. After 3 min, the reaction was stopped by rapid addition of 0.5 mL of 6 M H2SO4. The tubes were mixed thoroughly by inversion after which 1750mL of 0.01 M KMNO4 was added. Absorbance was read at 480 nm within 3 min.

3.6.4 Calculations

Activity = OD/min x V /

M x V x L x Y

Where OD = Absorbance

L= Light path

V= Total volume of reaction sample

M= Molar coefficient of H_2O_2 (40/m/cm)

V= Volume of sample

Y= mg protein in the sample

3.7 Estimation of Superoxide dismutase activity (SOD)

This was determined according to the methods of Masra and Fridorich (1972).

3.7.1 Principle

In this method, adrenaline quickly auto-oxidizes in aqueous solution to form adrenochrome, which can be detected at 420 nm using a spectrophotometer. This auto-oxidation process depends on the presence of superoxide anions. SOD reduces the rate of this reaction by catalyzing the breakdown of superoxide anions. Therefore, the extent of inhibition observed serves as an indicator of SOD activity. One unit of enzyme activity is defined as the amount of enzyme required to cause 50% inhibition of auto-oxidation.

3.7.2 Reagent and preparation

Assay Procedure

Sample homogenate (0.1 mL) was added to 0.625 mL of 0.05 M carbonate buffer (pH 10.2) and allowed to equilibrate. The reaction was initiated by the addition of 0.15 mL of freshly prepared 0.03 mM adrenaline as substrate. The solution was mixed by inversion. The reference tube contained 0.675 mL of carbonate buffer and 0.15 mL of adrenaline, while the blank contained 0.625 mL of carbonate buffer, 0.1 mL of distilled water and 0.15 mL of 0.03 mM adrenaline. The increase in absorbance at 420 nm due to the formation of adrenochrome was monitored every 30 sec for 120 sec. One unit of SOD activity was taken as the amount of SOD necessary to cause 50 % inhibition of the oxidation of adrenaline to adrenochrome within 120 sec.

3.8 Estimation of Glutathione peroxidase

This was determined according to Nyman (1959).

3.8.1 Principle

This is based on the oxidation of pyrogallol to purpurogallin by peroxidase activity, resulting to a deep brown color disposition, read at 430nm.

3.8.2 Reagent and preparation

Pyrogallol (20mM): 0.2552g of pyrogallol was dissolved in 100mls of distilled water.

3.8.3 Procedures

To an aliquot of plasma (0.1ml), 0.625ml of phosphate buffer, 0.625ml of H_2O_2, 1.5ml of distilled water and 0.625ml of pyrogallol was added.

The reaction was allowed to stand for 30mins at room temperature. A deep brown color was formed which was read at 480nm.

3.8.4 Calculations

Enzyme Activity = $\frac{OD/min \times Vt \times Df}{E \times Vs \times Y}$

where OD = Absorbance of test

Vt = Total volume of reaction mixture

Df = Dilution factor

E = Molar extinction coefficient (12/M/cm)

Vs = Volume of sample

Y = mg of protein used

3.8.5 Statistical Analysis

The statistical software for social sciences (SPSS) version 21.0 (IBM Inc. USA) was used to display and analyse the data from this study. Treatment groups for continuous variables were compared using analysis of variance (ANOVA).

CHAPTER FOUR

INTRODUCTION

The survival rate of Drosophila melanogaster exposed to varying concentrations of Knorr chicken seasoning was monitored over a 21-day period to assess its effect on longevity. Table 4.1 showed that there was a significant difference ($p = 0.006$) when comparing the control group to the groups administered different concentrations of Knorr chicken seasoning. On Day 5, the control group recorded a 72.4% survival rate, while the groups administered 0.3 g/ml, 0.15 g/ml, 0.10 g/ml, and 0.05g/ml of Knorr chicken seasoning had 68.5%, 77.1%, 81.0%, and 82.9% survival rates respectively. At Day 14, the control group showed a 42.9% survival rate, while the groups administered 0.3 g/ml KCS, 0.15 g/ml KCS, 0.10 g/ml KCS, and 0.05 g/ml KCS recorded 26.9%, 39.0%, 39.0%, and 48.6% survival rates respectively. By Day 21, survival rate in the control group was 22.9%, while 0.3 g/ml KCS, 0.15 g/ml KCS, 0.10 g/ml KCS, and 0.05 g/ml KCS groups had 8.3%, 18.1%, 16.2%, and 20.0% survival rates respectively (Table 4.1; Figure 4.1).

The activities of catalase (CAT), superoxide dismutase (SOD), and glutathione peroxidase (GPx) were also evaluated in Drosophila melanogaster following exposure to different concentrations of Knorr chicken seasoning. Table 4.2 shows that there was no significant difference in catalase activity across the groups ($p = 0.624$). The control group recorded 0.017 ± 0.005 U/g protein, while 0.3 g/ml KCS, 0.15 g/ml KCS, 0.10 g/ml KCS, and 0.05 g/ml KCS groups showed 0.049 ± 0.023, 0.034 ± 0.021, 0.023 ± 0.009, and 0.024 ± 0.008 U/g protein respectively, indicating slight increases in CAT activity but not statistically significant (Figure 4.2).

Superoxide dismutase (SOD) activity showed a significant difference among the groups ($p = 0.012$). The 0.3 g/ml KCS group recorded the highest activity (0.341 ± 0.014 U/g protein), which was significantly higher than the control (0.101 ± 0.017). The 0.15 g/ml KCS group

(0.174 ± 0.093) also showed elevated activity compared to the control, while the 0.10 g/ml KCS group (0.047 ± 0.015) recorded the lowest activity, significantly different from both the control and higher concentration groups. The 0.05 g/ml KCS group (0.098 ± 0.048) showed activity similar to the control, indicating partial overlap (Figure 4.3).

Glutathione peroxidase (GPx) activity did not differ significantly among the groups ($p = 0.984$). The control group recorded 0.282 ± 0.003 U/g protein, while the 0.3 g/ml KCS, 0.15 g/ml KCS, 0.10 g/ml KCS, and 0.05 g/ml KCS groups had 0.295 ± 0.007, 0.251 ± 0.128, 0.263 ± 0.005, and 0.274 ± 0.008 U/g protein respectively, suggesting that Knorr seasoning had no notable modulatory effect on GPx activity (Figure 4.4).

Table 4.1. Survival Analysis and Log-rank Test for Drosophila melanogaster Administered Different Concentrations Knorr Chicken Seasoning

Day	Control (%)	0.3g/ml (%)	0.15g/ml (%)	0.1g/ml (%)	0.05g/ml (%)	Logrank test for trend	P value
0	86.7	94.4	94.3	91.4	95.2	1	0.006
1	80	89.8	91.4	90.5	93.3		
2	79	86.1	87.6	88.6	90.5		
3	75.2	76.9	86.7	83.8	84.8		
4	75.2	71.3	82.9	82.9	84.8		
5	72.4	68.5	77.1	81	82.9		
6	67.6	62	75.2	72.4	76.2		
7	64.8	59.3	67.6	63.8	69.5		
8	64.8	51.9	64.8	61	67.6		
9	61	50	62.9	56.2	65.7		
10	60	46.3	58.1	53.3	61		
11	50.5	41.7	52.4	51.4	59		
12	47.6	34.3	48.6	45.7	56.2		
13	43.8	32.4	41.9	41.9	56.2		
14	42.9	26.9	39	39	48.6		
15	41.9	25	31.4	38.1	41		
16	36.2	22.2	29.5	32.4	37.1		
17	33.3	19.4	25.7	26.7	31.4		
18	31.4	16.7	24.8	24.8	25.7		
19	28.6	16.7	24.8	24.8	23.8		
20	22.9	12	21.9	21	20		
21	22.9	8.3	18.1	16.2	20		

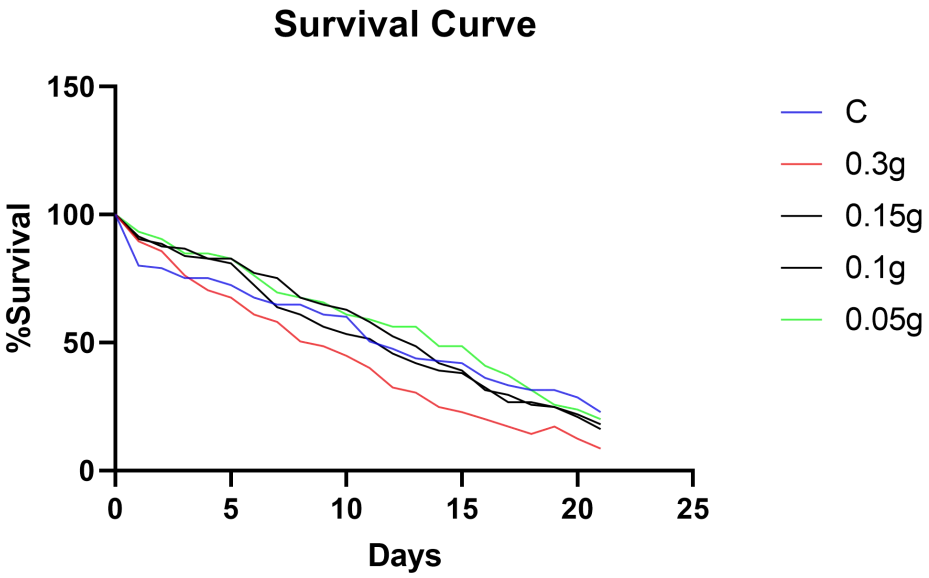

Figure 4.1. Survival curve showing survival rate of Drosophila melanogaster flies administered varied concentrations of Knorr Chicken Seasoning

Table 4.2: Effects of Knorr Chicken Seasoning on Antioxidant Enzyme Activities (CAT, SOD, and GPx) in Drosophila melanogaster

Parameter	Control	0.3 g/ml	0.15 g/ml	0.10 g/ml	0.05 g/ml	p-value
CAT (U/g Prot)	0.017 ± 0.005	0.049 ± 0.023	0.034 ± 0.021	0.023 ± 0.009	0.024 ± 0.008	0.624
SOD (U/g Prot)	0.101 ± 0.017[b]	0.341 ± 0.014[c]	0.174 ± 0.093[bc]	0.047 ± 0.015[a]	0.098 ± 0.048[ab]	0.012*
GPx (U/g Prot)	0.282 ± 0.003	0.295 ± 0.007	0.251 ± 0.128	0.263 ± 0.005	0.274 ± 0.008	0.984

Values are Mean ± SEM (n = 3). $p < 0.05$ indicates significance by one-way ANOVA. Superscripts ([a], [b], [c]) show Tukey's HSD comparison, where different letters indicate significant differences. GPx = glutathione peroxidase; SOD = superoxide dismutase; CAT = catalase.

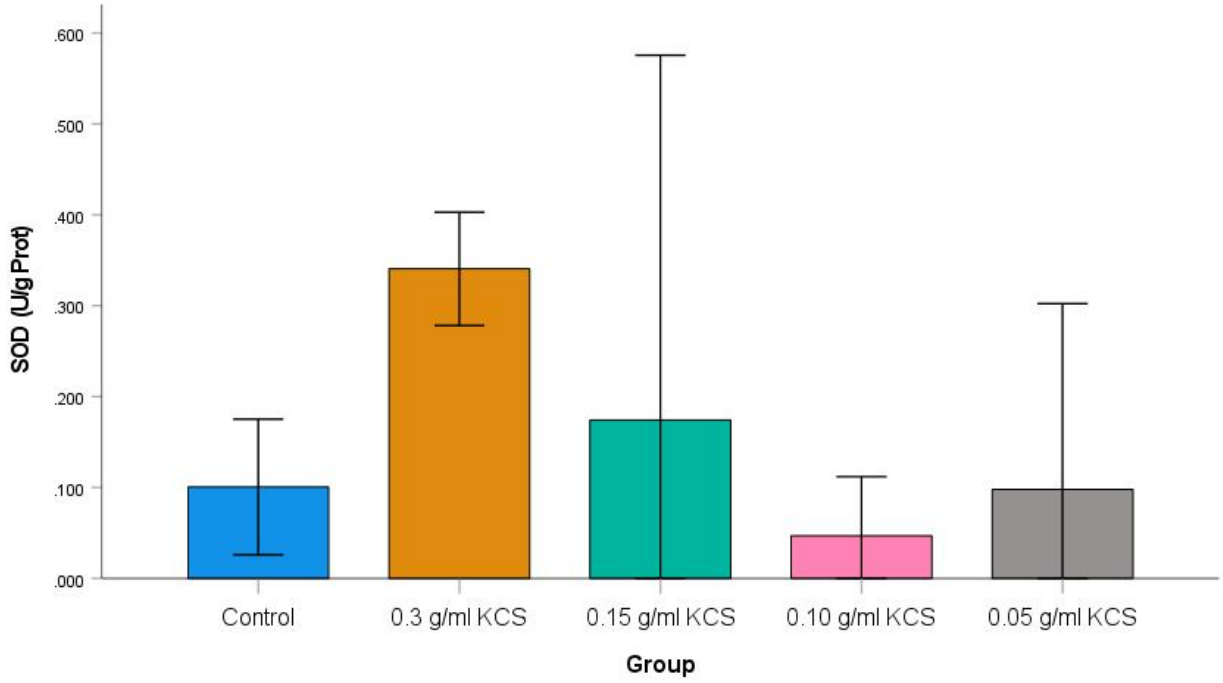

Figure 4.3: Superoxide Dismutase (SOD) Activity in Drosophila melanogaster Exposed to Knorr Chicken Seasoning

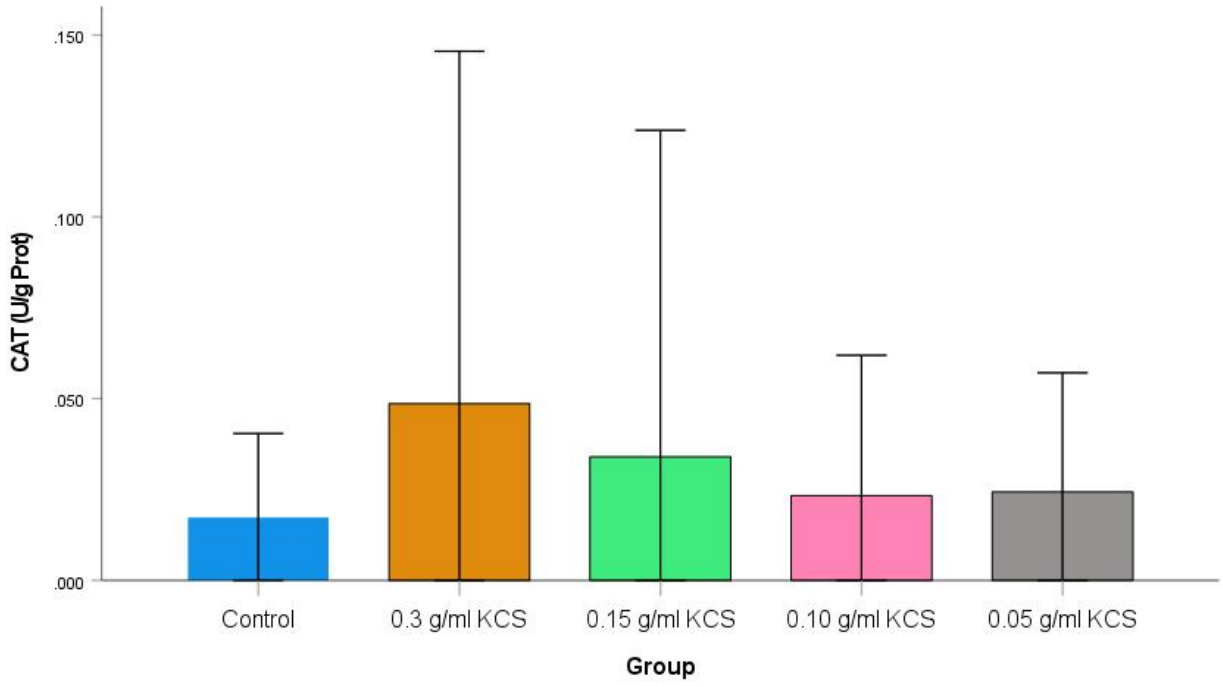

Figure 4.2: Catalase (CAT) Activity in Drosophila melanogaster Exposed to Knorr Chicken Seasoning

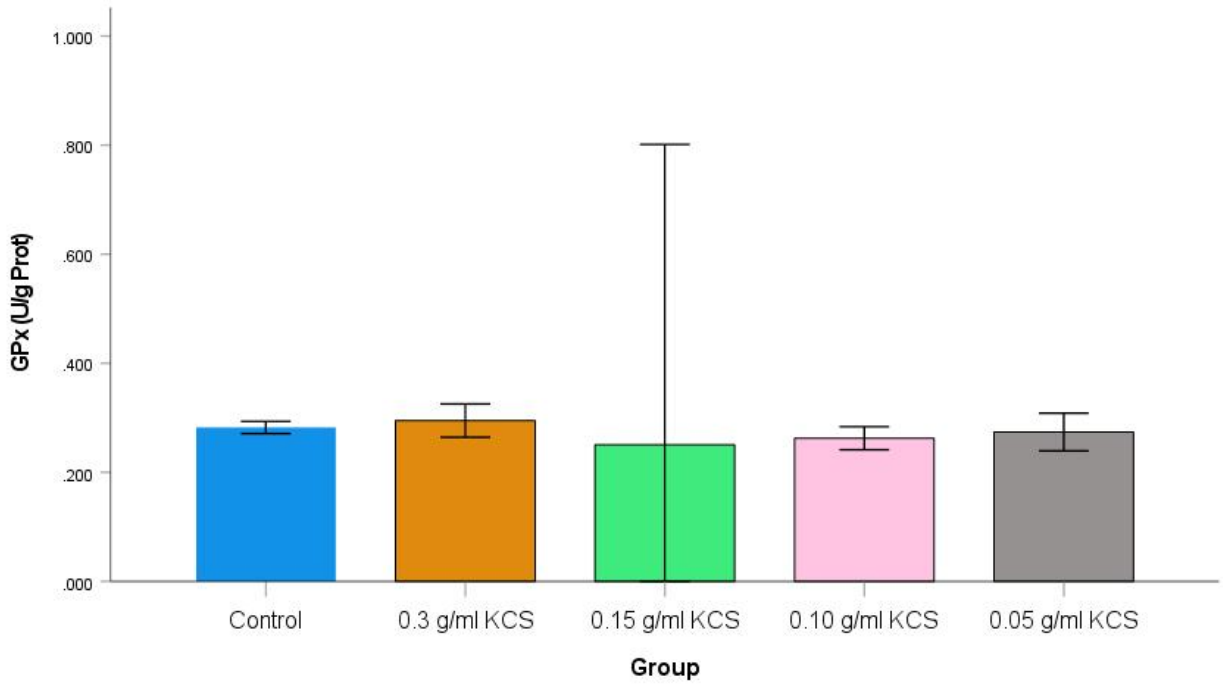

Figure 4.4: Glutathione Peroxidase (GPx) Activity in Drosophila melanogaster Exposed to Knorr Chicken Seasoning

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1 Discussion

The study investigated the modulatory role of Knorr chicken seasoning (KCS) on the survival rate and selected antioxidant enzyme activities in *Drosophila melanogaster*, an established model organism in biomedical and nutritional research. Seasonings such as Knorr cubes are household staples in Nigeria and across the globe, valued for their flavor-enhancing properties (Anaekwe, 2025). However, concerns about their health implications have grown due to the presence of high sodium levels, monosodium glutamate (MSG), artificial additives, and hydrolyzed proteins. While the sensory role of these cubes is undeniable, their biochemical and physiological effects remain incompletely understood, particularly in relation to oxidative stress (Oyeyinka *et al.,* 2017; Zhang *et al.,* 2020). The use of *Drosophila melanogaster* provides a useful model for addressing these gaps because of its well-characterized genetics, short life cycle, and conserved metabolic pathways that mirror human processes (Pandey and Nichols, 2011). For decades, *Drosophila* has been used to assess dietary interventions, toxicological exposures, and oxidative stress responses, thereby serving as a bridge between molecular mechanisms and whole-organism health outcomes.

One of the central aspects of this study was to assess survival rate in flies exposed to different concentrations of Knorr seasoning. The results showed that survival was significantly affected by concentration. High-dose exposure (0.3 g/ml) sharply reduced survival, while lower concentrations (0.05–0.10 g/ml) yielded better outcomes, sometimes even higher than control values. By day 21, the control group had 22.9% survival, compared to 8.3% at 0.3 g/ml. These findings corroborate earlier reports that excessive dietary salt or MSG reduces longevity in flies. Oyeyinka *et al.* (2017) reported that MSG reduces *Drosophila* lifespan by elevating reactive oxygen and nitrogen species, while Zhang *et al.* (2020) showed that high

sodium intake impairs stress tolerance, cardiac function, and survival. Similar trends have been observed with sugar- or fat-rich diets, which reduce survival through metabolic disruption and insulin resistance (Musselman *et al.*, 2011). The relatively better outcomes observed at low concentrations in this study may reflect hormesis a phenomenon in which mild stress activates adaptive defense mechanisms. Fontana and Partridge (2015) described this adaptive hormesis in dietary restriction models, where mild oxidative stress triggers the upregulation of stress resistance genes and antioxidant pathways, thereby extending lifespan. Thus, Knorr seasoning appears to have a biphasic effect, with low doses inducing protective responses while high doses overwhelm homeostatic systems.

The biological rationale for these outcomes is linked to oxidative stress and antioxidant defense. Oxidative stress arises when the production of reactive oxygen species (ROS) exceeds the capacity of antioxidant systems, leading to lipid peroxidation, protein oxidation, and DNA damage (Halliwell and Gutteridge, 2015). In flies, as in humans, three key antioxidant enzymes superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx) constitute the primary enzymatic defense system. SOD converts superoxide radicals into hydrogen peroxide, which is subsequently broken down by catalase and GPx into water and oxygen. Together, these enzymes form a tightly coordinated defense network against oxidative damage. When dietary or environmental stressors increase ROS generation, these enzymes are often upregulated as compensatory mechanisms (Rzezniczak *et al.*, 2011).

In this study, catalase activity showed no significant changes across groups, although treated flies recorded slightly higher values than controls. This suggests that while Knorr seasoning did not strongly activate hydrogen peroxide detoxification, subtle increases in CAT activity may reflect low-level ROS production. Similar stability in catalase has been reported in studies where oxidative stress was moderate; Halliwell and Gutteridge (2015) observed that catalase is often less inducible compared to SOD, responding mainly under conditions of

extreme ROS burden. The presence of spices such as garlic and onion in Knorr cubes could also contribute to maintaining catalase stability, since polyphenols and sulfur-containing antioxidants in these spices may neutralize ROS independently of enzymatic defenses (Surai, 2014).

SOD activity, by contrast, showed significant modulation. The 0.3 g/ml group recorded markedly elevated SOD activity, suggesting that high concentrations of Knorr seasoning produced strong oxidative stress, triggering compensatory upregulation of SOD. This finding is consistent with Rand *et al.* (2010), who showed that preservatives such as sodium benzoate increase SOD activity in *Drosophila* by inducing oxidative stress. It also aligns with earlier work demonstrating that MSG elevates ROS, leading to SOD activation as a defensive response (Oyeyinka *et al.*, 2017). Interestingly, the 0.10 g/ml group recorded the lowest SOD activity, even lower than control. This paradox may reflect enzyme inhibition or exhaustion under certain stress conditions, a phenomenon observed in studies where oxidative burden surpasses enzyme capacity, leading to reduced activity despite increased stress (Rzezniczak *et al.*, 2011). The biphasic SOD response therefore reflects the delicate balance between enzyme activation and inactivation under dietary stress.

Glutathione peroxidase activity, on the other hand, showed no significant differences between groups. This suggests that Knorr seasoning had minimal effect on GPx pathways, which are often more dependent on dietary selenium and other cofactors not manipulated in this study. Deepashree *et al.* (2021) noted that GPx activity is often stable in flies unless specific micronutrients are introduced or depleted. This finding also emphasizes the primary reliance of *Drosophila* antioxidant defense on SOD and CAT, while GPx plays a relatively secondary role under many experimental conditions.

The interplay between these enzymatic outcomes reflects the complex nutrient–gene interactions triggered by Knorr seasoning. Components such as sodium chloride, MSG, amino acids, and polyphenols interact with conserved signaling pathways in *Drosophila*. Sodium has been shown to activate osmotic stress pathways and impair lifespan (Na *et al.*, 2013), while MSG influences neurotransmission and oxidative stress pathways, sometimes inducing neurotoxicity at high levels (Parmentier *et al.*, 2016). On the other hand, polyphenols from spices may upregulate stress resistance genes such as dFOXO, promoting autophagy and antioxidant defenses (Greer and Brunet, 2008). Thus, the dual nature of Knorr seasoning becomes evident: it may act as a pro-oxidant at high concentrations but exhibit modest protective effects at lower doses.

These findings relates well with the broader literature. Musselman *et al.* (2011) and Partridge *et al.* (2011) highlighted how processed diets high in sugar or fat compromise survival, while Rand *et al.* (2010) documented lifespan reduction with preservatives. Conversely, Peng *et al.* (2011) showed that apple polyphenols prolonged lifespan and enhanced stress resistance in flies, supporting the possibility that polyphenolic components in Knorr cubes may partly buffer oxidative stress at low doses. In essence, Knorr seasoning embodies a balance of harmful and beneficial components: sodium and MSG promote oxidative stress, while herbs and plant extracts provide antioxidant protection. The final outcome depends largely on concentration and duration of exposure.

The implications of these results extend beyond experimental biology. Given the widespread daily use of Knorr seasoning in Nigerian households and globally, chronic high-dose exposure could pose long-term risks to oxidative balance and health, while moderate use may remain relatively safe or even mildly beneficial. By demonstrating concentration-dependent effects on survival and antioxidant enzymes, this study underscores the need for awareness and moderation in the consumption of processed food additives. Moreover, it validates

Drosophila melanogaster as a powerful, low-cost model for nutritional toxicology, capable of generating insights relevant to public health and food safety regulation.

5.2 Conclusion

In conclusion, this study has shown that Knorr chicken seasoning exerts concentration-dependent effects on the survival and antioxidant status of *Drosophila melanogaster*. At higher concentrations, it reduced survival and induced significant changes in SOD activity, reflecting oxidative stress. At lower concentrations, survival outcomes were relatively better, suggesting mild protective or hormetic effects, although catalase and glutathione peroxidase activities remained largely unaffected. These findings point to a dual role of Knorr seasoning, where its high sodium and MSG content can impose oxidative burden, while its plant-derived polyphenols may offer some antioxidant buffering. The broader implication is that while Knorr seasoning can be safely consumed at moderate levels, chronic and excessive intake could have long-term adverse consequences on oxidative balance and overall health.

5.3 Recommendation

Based on the findings of this study,

1. It is recommended that Knorr chicken seasoning and similar processed food additives should be consumed in moderation to minimize oxidative stress and associated health risks. While low concentrations may not significantly impair survival or antioxidant defenses, higher concentrations are detrimental to organismal health.
2. Further research using mammalian models is suggested to validate these findings and provide deeper insights into the long-term health implications of seasoning cube consumption. antioxidants from fruits, vegetables, and plant-based foods, thereby counterbalancing the pro-oxidant risks associated with processed additives

REFERENCES

Abdulrahman, F. I., Onyeyili, P. A., and Sani, F. G. (2019). Toxicological effect of monosodium glutamate in Wistar rats. *Journal of Medical Sciences*, 10(3), 99–105.

Abolaji, A. O., Olaiya, C. O., Oluwadahunsi, O. J., and Farombi, E. O. (2017). Dietary consumption of monosodium L-glutamate induces adaptive response and reduction in the life span of Drosophila melanogaster. *Cell Biochemistry and Function,* 35(3), 164–170.

Aquino-Miranda, G., Escamilla-Sánchez, J., González-Pantoja, R., Bueno-Nava, A., and Arias-Montaño, J. (2015b). Histamine H3 receptor activation inhibits dopamine synthesis but not release or uptake in rat nucleus accumbens. Neuropharmacology, 106, 91–101.

Bag, J., and Mishra, M. (2019). Biochemical Assays to Detect the Antioxidant Level in Drosophila melanogaster. *In Springer protocols handbooks/Springer protocols* (pp. 151–168).

Bastock, R., and St Johnston, D.(2008). Drosophila oogenesis. *Current Biology*, 18(23) R1082 - R1087.

Bellen, H. J., Tong, C., and Tsuda, H. (2010). 100 years of Drosophila research and its impact on vertebrate biology. *Nature Reviews Genetics*, 11(7): 517-530.

Bier, E. (2005). Drosophila, the golden bug, emerges as a tool for human genetics. *Nature Reviews Genetics,* 6(1), 9–23.

Burgering, B. M. T. (2008). A brief introduction to FOXOlogy. *Oncogene*, 27(16), 2258–2262.

Cagan, R. (2009). Chapter 5 Principles of Drosophila Eye Differentiation. *Current Topics in Developmental Biology/Current Topics in Developmental Biology,* 115–135.

Demerec, M., and Kaufman, P .(1996). Drosophila Guide: Introduction to the genetics and cytology of Drosophila melanogaster. *Cold Spring Harbor Laboratory.* 19(4): 4-8.

Dey, M., Ganguly, A., and Dahanukar, A. (2023). An inhibitory mechanism for suppressing high salt intake in Drosophila. **Chemical Senses**, 48, bjad014,1-10.

Eweka, A., and Om'Iniabohs, F. A. E. (2011). Histological studies of the effects of monosodium glutamate on the small intestine of adult Wistar rats. *Annals of Medical and Health Sciences Research*, 1(1), 21–29.

Farombi, E. O., and Onyema, O. O. (2006). Monosodium glutamate-induced oxidative damage and genotoxicity in the rat: Modulatory role of vitamin C, vitamin E, and quercetin. *Human & Experimental Toxicology*, 25(5), 251–259.

Fontana, L., Partridge, L., and Longo, V. D. (2010b). Extending Healthy Life Span—From Yeast to Humans. *Science*, 328(5976), 321–326.

Fontana, L., & Partridge, L. (2015). Promoting Health and Longevity through Diet: From Model Organisms to Humans. *Cell*, 161(1), 106–118.

Furman, D. P., and Bukharina, T. A. (2011). Drosophila mechanoreceptors as a model for studying asymmetric cell division. *The International Journal of Developmental Biology, 55(2),* 133–141.

Gholizadeh, H., Naserian, A. A., Xin, H., Valizadeh, R., Tahmasbi, A. M., and Yu, P. (2014). Detecting carbohydrate molecular structural makeup in different types of cereal grains and different cultivars within each type of grain grown in semi-arid area using FTIR spectroscopy with uni- and multi-variate molecular spectral analyses. *Animal Feed Science and Technology,* 194, 136–144.

Hales, K. G., Korey, C. A., Larracuente, A. M., and Roberts, D. M. (2015). Genetics on the Fly: A primer on theDrosophilaModel System. *Genetics*, 201(3), 815–842.

Halliwell, B., and Gutteridge, J. M. (2015). Free radicals in biology and medicine (5th ed.). Oxford University Press.

Halzerigg , D .,Blix, A . S ., and Stokkan, K. (2017). Waiting for the sun: The circannual program of reindeer is delayed by the recurrence of rhythmical melatonin secretion after the arctic night. *Journal of Experimental Biology.*

Jennings, B. H. (2011). Drosophila – a versatile model in biology and medicine. Materials Today, 14(5), 190–195. Kapahi, P., Chen, D., Rogers, A. N., Katewa, S. D., Li, P. W.

Lee, K. P., Simpson, S. J ., Clissold, F. J., Brooks, R., Ballard, J. W.O., Taylor, P. W and Raubenheimer, D. (2008). Lifespan and reproduction in Drosophila: New insights from nutritional geometry. *Proceedings of the National Academy of Sciences,* 105(7), 2498–2503.

Li,C., Fu, Y., Wang, Y., Kong, Y., Li, M., Ma, D., Zhai, W., Wang, H., Lin, Y., Liu, S., Ren, F., Li, J., and Wang, Y. (2017a). Mesenchymal stromal cells ameliorate acute allergic rhinitis in rats. *Cell Biochemistry and Function,* 35(7), 420–425.

Lopez-Ortiz, C., Gracia-Rodríguez, C., Belcher, S., Flores , G., Das , A., Nimmakayala , P., Balagurusamy , N ., and Reddy , U . (2023). Drosophila melanogaster as a translational model system to explore the impact of phytochemicals on human health. *International Journal of Molecular Sciences*, 24(17), 13365.

Markow, T. A., and O'Grady, P. M. (2008). Reproductive ecology of Drosophila. *Functional Ecology,* 22(5), 747–759.

Martinez, L. (2024). Exploring the health implications of Knorr stock pots: Are they bad for you? - HomeDiningKitchen.

Matsuo, E., and Kamikouchi, A. (2013). Neuronal encoding of sound, gravity, and wind in the fruit fly. *Journal of Comparative Physiology A, 199(4),* 253–262.

McKay, F. H., Lippi, K., Dunn, M., Haines, B. C., and Lindberg, R. (2018). Food-Based Social Enterprises and Asylum Seekers: The Food Justice Truck. Nutrients, 10(6), 756.

Montell, C. (2009). A taste of the Drosophila gustatory receptors. *Current Opinion in Neurobiology*, 19(4), 345–353.

Musselman, L. P., Fink, J. L., Narzinski, K., Ramachandran, P. V., Hathiramani, S. S., Cagan, R. L., and Baranski, T. J. (2011). A high-sugar diet produces obesity and insulin resistance in wild-typeDrosophila. Disease Models and Mechanisms, 4(6), 842–849.

Nishimura, T., Yamada, K., Fujimori, C., Kikuchi, M., Kawasaki, T., Siegfried, K. R., . . . Tanaka, M. (2018). Germ cells in the teleost fish medaka have an inherent feminizing effect. PLoS Genetics, 14(3), e1007259. .1007259

Pandey, U. B., and Nichols, C. D. (2011). Human disease models in Drosophila melanogaster and the role of the fly in therapeutic drug discovery. *Pharmacological Reviews,* 63(2), 411–436.

Partridge, L., Alic, N., Bjedov, I., and Piper, M. D. (2010). Ageing in Drosophila: The role of the insulin/Igf and TOR signalling network. Experimental Gerontology, 46(5), 376–381.

Peng, C., Chan, H. Y. E., Huang, Y., Yu, H., and Chen, Z. (2011a). Apple Polyphenols Extend the Mean Lifespan of Drosophila melanogaster. *Journal of Agricultural and Food Chemistry*, 59(5), 2097–2106.

Rodríguez-Moreno, A., González-Rueda, A., Banerjee, A., Upton, A. L., Craig, M. T., and Paulsen, O. (2013). Presynaptic Self-Depression at developing neocortical synapses. *Neuron*, 77(1), 35–42.

Rzezniczak, T. Z., Merritt, T. J. S., and Promislow, D. E. L. (2011). A test of oxidative stress theory using Drosophila melanogaster. *Mechanisms of Ageing and Development,* 132(3), 123–130.

S., Shivanandappa, T., & Ramesh, S. R. (2021b). Genetic repression of the antioxidant enzymes reduces the lifespan in Drosophila melanogaster. *Journal of Comparative Physiology B, 192(1), 1–13.*

Sugimoto, T. N., Fujii, T., Kayukawa, T., Sakamoto, H., and Ishikawa, Y. (2010). Expression of a doublesex homologue is altered in sexual mosaics of Ostrinia scapulalis moths infected with Wolbachia*. Insect Biochemistry and Molecular Biology, 40(12), 847–854.*

Suh, H. J., Shin, B., Han, S., Woo, M. J., and Hong, K. (2017). Behavioral Changes and Survival in Drosophila melanogaster: Effects of Ascorbic Acid, Taurine, and Caffeine. *Biological and Pharmaceutical Bulletin*, 40(11), 1873–1882.

Thomas, E. L., and Kockel, L. (2010). With TOR, less is More: a key role for the Conserved Nutrient-Sensing TOR pathway in aging. *Cell Metabolism,* 11(6), 453–465.

Tolwinski N,2017.Introduction:Drosophila _A model system for development biology. *Journal of developmental biology* ,5(3),1 -2.

Valko, M., Leibfritz, D., Moncol, J., Cronin, M. T., Mazur, M., and Telser, J. (2006). Free radicals and antioxidants in normal physiological functions and human disease. *The International Journal of Biochemistry and Cell Biology*, 39(1), 44–84

Walter, A., Eichler, K., Selcho, M., Thum, A. S., and Pauls, D. (2018). Odor-taste learning In Drosophila larvae . Journal of Insect physiology. 106(1): 47-54.

Walter, F. (2025). Unpacking the truth: Is Knorr stock cubes healthy? - FlavoryCooking. Flavory Cooking.

Wood, J. G., Rogina, B., Lavu, S., Howitz, K., Helfand, S. L., Tatar, M., and Sinclair, D. (2004). Sirtuin activators mimic caloric restriction and delay ageing in metazoans. *Nature*, 430(7000), 686–689.

Montell, C. (2009). A taste of the Drosophila gustatory receptors. *Current Opinion in Neurobiology,* 19(4), 345–353.

Admin. (2022, September 30). drosophila-melanogaster.

Anaekwe, E. N. (2025, January 16). Flavoring success: The booming market for seasoning cubes production in Nigeria. *Feasibility Reports in Nigeria.*

Dean, C. (2025, June 23). Uncovering the truth: Is Knorr chicken bouillon powder a healthy addition to your meals? - TheRealFlavors.Deepashree,