Pak. j. life soc. Sci. (2024), 22(1): 2464-2475 E-ISSN: 2221-7630;P-ISSN: 1727-4915

Pakistan Journal of Life and Social Sciences
www.pjlss.edu.pk

https://doi.org/10.57239/PJLSS-2024-22.1.00183

RESEARCH ARTICLE

The Effect of Amoebic Dysentery on Some Physiological Parameters

Wafaa Ekrayyem Mahmood[1*], Ashraf Jamal Mahmoud Zangana[2], Hanan Shihab Ahmad[3]

[1,2]Coll. of Edu. For women, Bio. Department, Tikrit University, Iraq.
[3]Al-Dour Technical Institute, Immediate Ambulance Department, Northern Tech. University.

ARTICLE INFO

Received: May 22, 2024

Accepted: Jul 3, 2024

Keywords

Entamoeba histolytica

Amoebic dysentery

Some physiological criteria

***Corresponding Author:**

dr.ashraf-bio@tu.edu.iq

ABSTRACT

The incidence of amoebic dysentery was recorded at a percentage of 26.66%. Stool samples were collected from the Balad General Hospital laboratory for age groups that ranged between (1-60) years and for both sexes for the period from December 2022 until May.

The results of the current study showed high significant differences for the blood parameters PLT, Granulocytes, Monocytes, for those infected with the Entamoeba histolytica parasite between males and females compared to healthy ones. As for Ferritin, it showed a high significant difference between infected females and healthy males, and there was no significant difference between males. Infected people And healthy females. As for Lymphocytes, HGB, and HCT, no significant differences appeared between affected males and females compared to healthy ones. A significant increase was recorded in those infected with the parasite compared to healthy people, and with regard to the blood standard, platelet elevation in those infected with amoebic dysentery, and there appeared to be a significant difference in the rate of mononuclear cells between the group infected with the parasite compared to healthy people. Regarding lymphocytes, it was recorded that there was a high significant decrease in the level of ferritin between females infected with the parasite and healthy males.

INTRODUCTION

Entamoeba histolytica is one of the intestinal protozoan parasites that causes what is known as amoebiasis (Ali, 2015). The main cause of diarrhea, especially in children, infection begins with the ingestion of infective stags, represented by the cystic form found in contaminated drinks and food. Dysentery is known as an infection resulting from tissue decomposition and may be symptomatic or asymptomatic (Pereira et al., 2014). The infection spreads throughout the world, and poses a serious threat to health in tropical and subtropical developing regions (Gupta et al., 2022) as well as in developed countries (Gwairgi and Ghildyal, 2018).

The amoeba parasite E. histolytica infects up to 90 million people each year, with a mortality rate exceeding 100,000 people annually in all countries of the world (Wesel et al., 2021). This parasite causes amoebiasis and can develop into liver abscess and amoebic colitis, which is listed among the 15 most important causes of diarrhea in the first two years of life of children living in the developing world (Gupta el al., 2022). The life cycle of the parasite passes through four stages, which is the vegetative stage or what is called the active Trophozoite, the precyst phase, the cyst phase, and the post-cyst phase (Mitchell et al., 2023). This type of amoeba is distinguished from the rest by its ability to infect tissues and decompose them, and for this reason it is called histolytic amoeba. In most

infections, damage occurs at the level of the mucous layer, and symptoms may be mild or non-existent, Asymptomatic, it is possible for the infected person to be a carrier of the disease only without showing symptoms, The infection here is known as a non-invasive infection, and the infected individuals do not have symptoms. Asymptomatic carriers, such that the excretion of cysts with feces is not accompanied by disease symptoms, and these individuals are an important cause of the epidemiology and spread of the parasite, and most of the infections caused by this parasite are from Without symptoms, but in cases of severe infection, it causes diarrhea, vomiting, pain, and weight loss, especially in children. The variation in infections is due to the different virulence factors of this parasite. When the feeding phase of the parasite is present in the lumen of the large intestine, it begins to adhere to the mucous tissue, decompose it, then penetrates it and destroys the epithelial tissue, which provokes an inflammatory condition. During this process, the parasite analyzes and devours immune cells and red blood cells and degrades them, thus causing a decrease in the size of PCV (Al- Mansup et al., 2022).

The infection is transmitted when eating contaminated food and drink. The infection occurs by swallowing the infectious cysts with contaminated food and water or from contaminated hands. It passes through the stomach without being affected and does not show any activity in the acidic environment. When it reaches the basic environment in the small intestine, it is stimulated and escape from the excystation cyst occurs and division begins. The cytoplasm and nuclear form are composed of eight small amoebulas, and the post-cystic trophic stages are similar to the mature trophic stages but differ in size (Ebert et al., 2020).

The autotrophs live and multiply in the crypts of the mucous layer of the large intestine and feed on the mucous secretions. There is also a metabolic interaction or interaction with the intestinal bacteria. The autotrophs usually begin tissue invasion when they decompose the mucous cells with hydrolytic enzymes and absorb the decomposed product, and ulcers occur in the intestinal wall. It may continue to penetrate until it reaches beneath the superficial lining, and may spread sideways into the submucosal layer, forming a flask-shaped ulcer. The ulcer may develop in the cecum, appendix, ascending colon, ileocecal valve, terminal ileum, sigmoid colon, and rectum, and may reach the lower blood vessels, and from here. It may travel with the blood through the hepatic portal vein, forming systemic amoebiasis or extraintestinal amoebiasis, and it continues to grow and multiply in the liver cells, causing amoebic liver abscess. It may reach the lung when it penetrates the diaphragm after infecting the liver, and it may be transmitted from the liver to the brain or skin via Through the bloodstream, the active stage may remain in the lumen of the large intestine, and when unsuitable environmental conditions are available, it begins to multiply and divide, and the mature cysts are thrown out with the feces to infect another new host, and so the life cycle continues (Selberherr et al., 2022).

Some cases of nutritive phases remain in the intestinal lumen for a limited period and are called non-invasive infection, the rate of infection reaches 90%. Individuals infected with this condition are called asymptomatic carriers of the disease, the cysts emerge with the feces without showing any symptoms, and these individuals represent an important source of epidemiology, the parasite (Guillen and Nancy, 2021). The remaining 10% of pathogenic infections attack the mucous layer of the intestine and may penetrate it and pass through it into the bloodstream to infect sites outside the intestine, such as the liver, spleen, brain, skin, heart, and lung (Guillen and Nancy, 2023).

The success of parasite infection depends on many factors, including: the amount of dose, the virulence of the parasite, intestinal motility, the host's diet, the presence or absence of intestinal bacteria normal flora, the ability of the amoeba to adhere to colonic mucosal cells, and the activators penetrate the epithelial cells in the colon by means of their movement and enzymes that It possesses a histolysin enzyme and a lytic enzyme that causes damage to the mucous membranes, and Lactin

mediates the adhesion of the active phase to host cells such as mucous cells in the colon (Guillen and Nancy, 2023).

Histolytica amoebiasis releases the enzyme (EhCPs) cysteine proteinase E. histolytica around itself. This enzyme works to decompose intercellular proteins such as Collagen and Fibronectin, which leads to the separation of epithelial cells from each other and their attachment to the enzyme (Miller et al., 2022). The hydrolytic enzymes secreted by the parasite disrupt the mucous membranes. The intestine and the barriers formed by epithelial cells, thus facilitating the process of penetrating tissues, and decomposing the intestinal mucosal cells down to the submucosal layer and other layers underneath it, as they work to decompose the host cells, and form separate pin-like ulcers with raised edges and are more numerous in the colon and mucous membrane area (Guillen and Nancy., 2023).

The disease may develop to affect the liver, and a liver abscess arises from the spread of pathogens through the blood vessels, the center of the abscess contains brown pus, which is liquefied liver tissue free of amoebae. The liver abscess may be single or multiple and is usually located in the right upper lobe of the liver. Then, it puts pressure on the bile ducts and is accompanied by an increase in the number of white blood cells to 20,000 cells/cm3 and an increase in the rate of red blood cell sedimentation. The amoebiasis may reach the lungs or the brain, causing a pulmonary or brain abscess, or it may reach any other organ, and the pulmonary abscess may explode. Directly in the lungs or explodes outward under the skin to lead to amoebic dermatitis (Mehlhorn, 2016).

The incubation period varies from several days to several months or years, and generally ranges between 1-4 weeks. The parasite may exist in some people for several years without any disease appearing in the host, but suddenly symptoms of the disease appear, such as amoebic colitis. Amoebic colitis occurs gradually, with symptoms appearing and increasing from one to two weeks. What distinguishes amoebic colitis from bacterial dysentery is diarrhea, which is one of the most common symptoms, as bacterial diarrhea is watery. Patients with amoebic colitis usually suffer from Watery or bloody diarrhea, abdominal pain, cramps, and weight loss (Slater et al., 2019). Healing occurs spontaneously if tissue erosion is minimal and regeneration processes are faster than destruction, and the nutritional phases are destroyed or stopped in the muscular layer of the intestine. The damage may develop to include parts close to the ascending colon and the cecum. In other cases, it may develop into an amoebic granulomatous tumor, which is a mass. A tumor-like disease known as amoeboma. It forms on the intestinal wall and sometimes grows very efficiently, leading to blockage of the lumen. Other symptoms include amoebic appendiatitis and fulminant colitis. The symptoms resulting from the infection vary, and the reason is due to the nature of the parasite strain that is resistant to natural or acquired immunity. of the host, the interactions that occur with the bacterial flora, the psychological state as well as the functional state of the host, as well as the genetic predisposition of the host, in addition to other factors represented by malnutrition, age, immune competence, and gender (Roberts et al., 2013)

The spread of infection varies greatly because some settings appear to be more susceptible than others, such as mental hospitals, prisons, and asylums. Acutely ill patients with invasive amoebiasis represent an important source of transmission of the disease because they pass through the infective phase, which is able to survive outside the environment. Intestinal environment (Bogitsh et al., 2018).

Heamoglobin Hb, where Hb is in the form of a red pigment present inside the red blood cell, is a protein consisting of two main parts: the first is represented by the iron-containing protein called haem, while the second part is globin. The functions of hemoglobin include transporting oxygen O2 from the lungs to the tissues and transporting carbon dioxide CO2 from the tissues to the lungs (Kabir Tamanna et al., 2023). The Hb percentage increases in the case of dehydration resulting from acute diarrhea, continuous vomiting, and in the case of severe burns. Also, an increase in the percentage of red blood cells in smokers leads to an increase in the hemoglobin rate, while the Hb percentage

decreases in the case of anemia and also in cases of bleeding. Hemorrhage, continuous blood loss, leukemia, and hypothyrodisim (Charles, 2020).

(P.C.V)) Packed Cells Colume, which is a process to measure the percentage of the volume of compressed red blood cells to the total volume of blood, as it is related to the number and size of red blood cells. A decrease in PCV may occur in many cases, including bleeding, destruction of red blood cells, bone marrow failure, and poor blood circulation. Absorption and malnutrition (Yoshida et al., 2019). During studies conducted by (Roberts et al., 2019), a decrease in PCV was observed in patients with amoebic dysentery, and anemia in patients with amoebic liver abscess (Alaboudi et al., 2023).

Total Leucocytes Count: White blood cells are cells with nuclei found in the blood to provide defense against germs, parasites and tumors. In general, they have defensive functions against foreign bodies that invade the body. Their number in adults ranges from 10 to 4 thousand cells/cubic ml Al-Shaibani et al. 2020).

In some physiological cases, an increase in the number of white blood cells (leucocytosis) occurs during exercise, emotional reactions, and the birth of recent children, pregnant women, and stress. In other cases, including splenectomy, there are some medications that increase the number of these cells, including Epinephrine, Heparin, Corticosteroid, and Aspirin. There are other medications that reduce the number of these cells, including Antihistamine, antithyroid drugs. The number of white blood cells also increases in some diseases, including leukemia, anemia, burns, and bleeding. There is also a decrease in white blood cells (leukopenia) in the event of a failure in bone marrow function. , tumors, fibrosis, blood poisoning, malaria, typhoid fever, and exposure to radiation (Cheng et al., 2019).

Differential Leucocyte Count There are 5 types of white blood cells that differ in their sizes, proportions, functions, and contents:

A - Neutrophils: The diameter of these cells ranges between 40-70 microns. Their number increases during bacterial infections, acute infections, burns, and stress, and decreases when exposed to radiation and vitamin B12 deficiency, as well as taking some medications (Hammad et al., 2022).

B - Eosinophils: The shape of these cells is circular, their diameter is 12-15 microns, their color is orange to red, and their nucleus has two lobes. The percentage of these cells is 1-4%, and their percentage may sometimes reach 1-5%. The numbers of these Eosinophlia cells increase in cases of allergic diseases and parasitic worm infections. , skin diseases and autoimmune diseases (HEGDE, 2019; Hammad et al., 2022; Cheng, 2019).

C - Basophiles: They are circular in shape, light purple in color, and their diameter is 11-13 microns. Their nuclei are S-shaped, their percentage is 0.5-1%. These cells increase in response to allergic responses, leukocyte cancer, and hypothyroidism, and their numbers decrease in pregnant women and stress. When thyroid secretions increase Hyperthyrodism (HEGDE, 2019; Cheng, 2019).

D- Lymphocytes: These cells are 7-10 microns in diameter and are bright red in color. Their nuclei occupy most of the pellet and their percentage is 20-40% of the total number of white blood cells (HEGDE, 2019). The numbers of these lymphocytes increase in some pathological conditions, including chronic infections and tuberculosis infections. Viral infections, whooping cough, immune diseases, and some types of leukemia, and a decrease in these cells occurs during severe and chronic infection with some diseases (Cheng et al., 2019).

E - Monocytes: The shape of these cells is somewhat irregular and they are the largest of the white cells, with a diameter of 10-20 microns, and their nuclei are shaped like a kidney or a bean. The average number of these cells is 2-8 (HEGDE, 2019). These cells increase during viral and fungal infections. Tuberculosis and some types of cancer, and the number of these cells rarely decreases (Russell et al., 2019).

Ferritin is a blood protein that contains iron that is stored in the body. It is called the "store" of iron in the body, but an imbalance occurs in the iron stores in the body, whether increased or decreased; it can cause several annoying symptoms that lead to serious diseases such as heart failure (Shin et al., 2023). It has also been documented that it is reduced in the case of intestinal infection with dysentery amoeba (Lee et al., 2022).

The aim of the study is to evaluate the extent of the effect of amoebic dysentery on some physiological parameters such as WBCS count, Hb, PCV, and Ferritin.

MATERIALS AND METHODS

1- Collection of stool samples: The study included collecting 225 feces samples from people lying in bed and attending Balad General Hospital and some private laboratories in Salah al-Din Governorate who were suffering from illness symptoms such as fever, diarrhea, loss of appetite, and others, during the period from December 2022 until May 2023 and for different age groups. The samples were placed in dry, clean plastic containers with a capacity of 30 ml, with a wide opening and a tight lid to prevent the sample from drying out and to maintain its moisture. A paper sticker was placed on one side of it to record the patient's name and sample number. Other information was taken from the patients, such as age, gender, residential location, and educational level.

2- Collection of blood samples: Blood samples were drawn from patients suffering from amoebic dysentery, as the number of those infected reached 38, and 10 samples were drawn from people who do not suffer from amoebic dysentery. They were used as a control group and from different age groups. To draw blood, clean, sterile 5ml medical syringes, drawing 5ml of venous blood using a tourniquet. It was placed in a disposable tube free of any substance, the blood was left in it for 10 minutes, then it was placed in a centrifuge at a speed of 3000 r/min and for 3 minutes the blood serum was observed to separate. The serum was withdrawn using a micropipette and placed in an eppendorf and stored at -20°C for the purpose of performing serological tests.

3- Examination of stool samples: Stool samples were examined by preparing a direct wet swab to detect the presence of cystic or nutritive stages of the amoebic dysentery parasite. Two slides were prepared for each sample using clean glass slides. I placed a small drop of 1% local iodine solution or 0.85% saline solution on the slide and mixed well, adding a small amount of feces and mixing using stick wood. Then the cover slide was placed well, and the sample was examined using a microscope. Optical imaging under 40x magnification power and then under 100x power (WHO, 1991).

4- Blood tests: Complete Blood Count (CBC): I use this device to give a complete picture of the components of the blood. I use blood tubes containing the anticoagulant EDTA, which works to prevent blood cells and other blood components from colliding with each other and contributes to giving correct results, as well as to ensure the safety of the device's operation. Obstruction of its ducts occurs if clotted masses of blood components pass through. It is used to count red blood cells, white blood cells, and platelets. The device has two chambers, the first of which hemoglobin and white blood cells are measured by analyzing red blood cells with the help of a substance that breaks down the red blood cells and produces hemoglobin, which is measured by a spectrophotometer, while the second chamber is in which platelets and red blood cells are measured. The passage of an electric current leads to a distinction between the components. According to the volume of blood passed through it, the results are recorded on a printer connected to the device. It used to measure the percentage of Hb, PCV, and WBC (Buttarello.2008).

5- Statistical Analysis: The program Statistical analysis system-SAS (2010) was used in the statistical analysis of the studied data to study the effect of various factors on the studied traits. The significant differences between the means were compared with the least significant difference (LSD) test, and the percentage differences between them were compared with a square test. Chi-square).

RESULTS AND DISCUSSION

Faecal samples were collected from the Balad General Hospital laboratory for age groups that ranged between (1-60) years and for both sexes for the period from the beginning of December 2022 until the end of May 2023, and the E. histolytica parasite was diagnosed through microscopic examination of the samples. Faeces were found in 60 samples out of 225 samples, with a percentage of 26.66% Table 1.

The results of this study are consistent with what was recorded by (ALYassaree, 2004) in Babil Governorate, where he recorded an infection rate of 29.5%, while they did not agree with what (Kadir et al., 2018) recorded in Tikrit, and with what (Ibraheem, 2008) recorded in the city of Kirkuk, where the infection rate reached 41.1% when examining 1,250 samples for children under 5 years of age, and what was recorded by (Ismail, 2006), where he recorded in his study an infection rate of 47.7% in the city of Kirkuk, and what was recorded by (Ibraheem, 2018) in Baghdad, where the rate reached 19.5%. And what Al-Masoudi (2009) found in Babylon, he recorded an infection rate of 34.3%.

The difference in the rate of parasite infection in this study and the studies mentioned may be due to the difference in the level of sanitation, population density, personal hygiene, climatic conditions, geographical location, the number of samples examined, the extent of the study and the age groups in the population on which the study was conducted. As for the similarity in the rates. The incidence may be due to similarity in cultural, social, and health levels (Kurt et al., 2007).

The results of the current study showed high significant differences for the blood parameters PLT, Gran, Mono, for those infected with the E. histolytica parasite between males and females compared to healthy ones. As for Ferritin, it showed a high significant difference between infected females and healthy males, and there was no significant difference between males. Infected people and healthy females. As for Lympho, HGB, and HCT, no significant differences appeared between affected males and females compared to healthy ones, as in Table 2.

The current study showed that there was a significant increase in blood platelet levels in people infected with the parasite compared to healthy people, because amoebic dysentery is considered an inflammatory disease, where inflammation leads to an increase in the production of platelets from the bone marrow. Amoebic dysentery can cause rupture of the affected area. In the mucous membrane of the intestine, where the body responds to this rupture by increasing the production of platelets to help in the blood pooling process, as high platelets are a compensatory response to the blood loss that occurs as a result of amoebic dysentery, as the body tries to compensate for the blood by increasing the production of platelets, and it agreed with (AI). Salehy and Mohammad, 2020),

The current study showed that there is a significant difference in the rate of mononuclear cells between the groups infected with the parasite compared to healthy people. The increase in mononuclear cells is due to the body's inflammatory response to confront the parasite infection. Their increase indicates the body's attempt to overcome the parasitic infection. (Duttaroy et al., 2021) The current study recorded a significant difference with regard to the blood standard (Russell et al., 2019) in those infected with the parasite compared to healthy people. The reason why the hemoglobin level is not affected depends on the period of infection, as if the infection is acute and short-term, it may not affect the hemoglobin level, as it depends on the patient's health condition in general and also depends on good nutrition (Ahmed et al., 2020.

The reason why the agglutinated cells were not affected may be due to the ability of the agglutinated cells to reproduce and replace damaged cells more quickly than dysentery. The percentage of these cells is not affected except in the case of severe inflammation or the presence of other digestive problems in the healthy group. Our results showed that there was no significant difference between the groups of infected people to the parasite compared (Yoshida et al., 2019).

Regarding lymphocytes, the current study showed a high significant difference in the level of ferritin between females infected with the parasite and healthy males. The current study recorded a significant decrease in ferritin for females compared to healthy males. The results of our study agree with (Zeki et al., 2019). The reason for the decrease in ferritin is that infection with the parasite leads to damage to the intestinal lining, which negatively affects the absorption of nutrients, especially iron. Infection with the parasite may also cause bleeding in the intestine, whether apparent or hidden. This continuous bleeding leads to blood loss and thus Loss of iron present in the blood, which leads to a decrease in the level of ferritin. In some cases, chronic inflammation may occur in the intestine as a result of repeated infection with the parasite. This chronic inflammation may lead to a decrease in the level of ferritin. The results showed that both gender and age are significantly related to the decrease in levels. Iron in the blood in both infected and control groups. Some studies describe dysentery amoeba as breaking down blood cells by... (Al-Hadraawy, 2019) The parasite releases hydrolytic enzymes in large quantities into the intestinal lumen, where these enzymes break down tissues to obtain proteins and iron, which it adopts as a source of food (Teixeira et al., 2008). Infection with dysentery amoeba is accompanied by the presence of blood in the feces, and this can be explained. This is on the basis that the parasite causes disturbance in the digestive system, as its mobile feeding phase adheres to the villi of the intestine and absorbs nutrients from them (Satoskar et al., 2009). The parasite also secretes histolytic proteins that decompose the host's tissues. Thus, the parasite is able to destroy the intestinal mucous layer to penetrate the tissues and destroy them, causing blood bleeding and loss of red blood cells (Chimire & Mishra, 2005; Ankri, 2002). The parasite has the ability to devour human red blood cells (Erythrophagocytosis) and analyze their plasma membrane. The ability of the feeding phases of the parasite to degrade red blood cells is due to the mechanism of adhesion to cell surfaces, and inhibiting adhesion leads to a reduction in the pathogenicity of the parasite (Mora-Galindo et al., 2004; Nozaki & Nakada, 2006). Parasitic infection stimulates a number of immune defense mechanisms that it includes the production of both antibodies and immune cells, and the type of response that will prevail depends on the type of parasite and the stage of infection. The increase in the number of white blood cells may be due to the occurrence of an inflammatory immune response that occurred in the mucosal layer of the intestine and the submucosal layer. White blood cells are cells that have an immune function in addition to their other functions, so an increase in the number of white blood cells is associated with an increase in the immune response during Parasitic infestation (MacDonald et al., 2002; Figuerola et al.; 1999;). The white blood cells secrete toxic products that decompose the feeding phase of the dysentery amoeba through adhesion and lysis mechanisms of the pathogen (Salata et al., 1985). T-cells participate in the cellular immune response, as well as secreting cytokines and their role in stimulating B-cells to produce antibodies. Cytotoxic T cells also produce toxins that are destructive to tumor cells and cells infected with viruses and foreign microorganisms in the body (Cheesbrough, 2006; Bain, 2017).

Table 1: Percentage of the number of samples positive for E. histolytica parasite

Total number of samples tested	Number of infected samples	Percentage percentage
225	60	26.66 %

Table 2: Average blood image parameters for infected and healthy patients by gender

						WBC		
		Ferritin Mg/L	**PLT 10^9/L**	**HCT %**	**HGB g/dL**	**Gran 10^9/L**	**Mono 10^9/L**	**Lympho 10^9/L**
Patients	Males	65.53 ± 18.06 b	315.3 ± 32.9 a	37.11 ± 7.03 a	11.594 ± 2.236 a	7.847 ± 2.630 a	0.9824 ± 0.3592 a	2.976 ± 0.887 a
	Females	46.89 ±15.04 c	313.9 ± 31.5 a	35.43 ± 4.66 a	10.894 ± 1.416 a	7.278 ± 1.786 a	0.9944 ± 0.3115 a	2.450 ± 0.802 a
Healthy people	Males	120.00 ± 16.02 a	252.8 ± 33.0 b	34.74 ± 2.01 a	10.940 ± 0.358 a	3.540 ± 1.526 b	0.5400 ± 0.4280 b	1.940 ± 0.288 a
	Females	74.20 ± 5.85 b	246.2 ± 37.8 b	34.98 ± 2.43 a	11.000 ± 0.515 a	4.060 ± 1.024 b	0.4800 ± 0.0837 b	1.760 ± 0.666 a

*Similar letters indicate that there are no significant differences between the rates of the different groups. P ≥ at the probability level of 0.05.

*Different letters indicate significant differences between the rates of the different groups at .P ≥ 0.05 probability level

REFERENCES

Abdulqader, A. T., Al-Sammarie, A. M. Y., & Mustafa, M. A. (2022, May). A comparative environmental study of aqueous extracts of ginger and grapes to protect hepatocytes in Albino rabbits and a comparison of extracts in preserving Awassi lamb meat from oxidation. In IOP Conference Series: Earth and Environmental Science (Vol. 1029, No. 1, p. 012001). IOP Publishing.

Ahmed, Mostafa H., Mohini S. Ghatge, and Martin K. Safo. "Hemoglobin: structure, function and allostery." Vertebrate and invertebrate respiratory proteins, lipoproteins and other body fluid proteins (2020): 345-382.

Alaboudi, Safa Khalid Aziz, and Haitham Mohammed Al-Awadi. "Study of Some Immune and Blood Markers Associated with Infection with the Intestinal Parasite Entamoeba Histolytica in Diabetic Patients." HIV Nursing 23.3 (2023): 1267-1276.

Al-Hadraawy, Saleem Khteer, Fahim M. Deqeem, and Naser Jawad Kadhim. "Study role of hematological and leptin biomarkers in human infected with Entamoeba histolytica parasite." Journal of Physics: Conference Series. Vol. 1294. No. 6. IOP Publishing, 2019

Ali, I. K. M. (2015).Intestinal amebae. Clinics in laboratory medicine, 35(2), 393-422.

Ali, S. H., Armeet, H. S., Mustafa, M. A., & Ahmed, M. T. (2022, November). Complete blood count for COVID-19 patients based on age and gender. In AIP Conference Proceedings (Vol. 2394, No. 1). AIP Publishing.

Al-Mansup, Arwa Mohammed Mohammed, and Khaled Nasher Khatan. "Intestinal Protozoa (Entamoeba histolytica and Giardia lamblia) and their effect on some Hematological Parameters in Al-Manssora Hospitals, Aden, Yemen." University of Aden Journal of Natural and Applied Sciences 26.2 (2022): 201-212.

Al-Masoudi H. K. A. (2009). The effect of some plants extracts and drugs on immobilized cystenine protenase of Entamoeba histolytica isolated from diarrhea in AI- Exandaria Districts / Babylon province. Ph. D. thesis, Coll. Sci., Baghdad University.

Al-Salehy, Z. K. A., & Mohammad, Z. A. A. (2020).Relationship Between Fecal Calprotectin and Other immunological Parameters in Diarrheal children infected with Entamoeba Histolytica and Pathogenic Bacteria in Thi-Qar Province, Iraq. Plant Archives, 20(1), 1089-1095.

Al-Shaibani, Shurooq Wesam. "Infection with Entamoeba histolytica and its effect on some blood parameters in Najaf City." Journal of Physics: Conference Series. Vol. 1660. No. 1. IOP Publishing, 2020.

Al-Yassaree, H. F. (2004). Isolation and identification of three protozoal enteroparasites, Entamoeba histolytica, Giardia lamblia and Cryptosporidium parvum in Babylon province. M. Sc. Thesis, College of Science, AL-Kufa University.

Ankri, S. (2002). Strategies of the protozoan parasite Entamoeba histolytica to evade the innate immune responses of intestinal epithelial cells. Journal of BioSciences, 27 (6): 609-614.

Bain, B. J. (2017). A beginner's guide to blood cells. 3th. John Wiley & Sons Ltd, London: 151pp.

Bogitsh, B. J., Carter, C. E., and Oeltmann, T. N. (2018). Human parasitology. Academic Press.

Buttarella, M; plebani, (Jul 2008). Automated blood cell counts: state of the art. American journal of clinical pathology. 130(1), 104-16.

Charles Patrick Davis. Hemoglobin: Normal, High, and Low Levels and Causes, Retrieved on the 5th of December, 2020, from:

Cheesbrough, M. (2006). District laboratory practice in tropical countries. 2nd edn., Cambridge University Press, New York: 434 pp.

Cheng, Matthew P., et al. "Blood culture results before and after antimicrobial administration in patients with severe manifestations of sepsis: a diagnostic study." Annals of internal medicine 171.8 (2019): 547-554.

Chimire, T.R. & Mishra, P.N. (2005). Intestinal parasites and hemoglobin concentration in the people of two different areas of Nepal. Journal of Nepal Health Research council, 3(2).

Duttaroy, Asim K. "Role of gut microbiota and their metabolites on atherosclerosis, hypertension and human blood platelet function: a review." Nutrients 13.1 (2021): 144.

Ebert, Dieter, and Peter D. Fields. "Host–parasite co-evolution and its genomic signature." Nature Reviews Genetics 21.12 (2020): 754-768.

Figuerola, J.; Munoz, E.; Gutierrez, R. & Ferrer, D. (1999). Blood parasites, leucocytes and plumage brightness in the Cirl Bunting, Emberiza cirlus. Functional Ecology, 13: 594–601.

Guillén, Nancy. "Pathogenicity and virulence of Entamoeba histolytica, the agent of amoebiasis." Virulence 14.1 (2023): 2158656.

Guillen, Nancy. "Signals and signal transduction pathways in Entamoeba histolytica during the life cycle and when interacting with bacteria or human cells." Molecular microbiology 115.5 (2021): 901-915.

Gupta, Shipra, Layne Smith, and Adriana Diakiw. "Amebiasis and amebic liver abscess in children." Pediatric Clinics 69.1 (2022): 79-97.

Gwairgi, M. A., and Ghildyal, R. (2018). Nuclear transport in Entamoeba histolytica: knowledge gap and therapeutic potential. Parasitology, 1-10.

Hammad, Kareem A., et al. "Effect of Infection by Entamoeba Histolytica on Some Blood Parameters in Kufa City." Al-Mansour Journal 37.1 (2022): 9-16.

HEGDE, Roopa B., et al. Comparison of traditional image processing and deep learning approaches for classification of white blood cells in peripheral blood smear images. Biocybernetics and Biomedical Engineering, 2019, 39.2: 382-392.

Hsu, C. Y., Mustafa, M. A., Yadav, A., Batoo, K. M., Kaur, M., Hussain, S., & Nai, L. (2024). N2 reduction to NH3 on surfaces of Co-Al18P18, Ni-Al21N21, Fe-B24N24, Mn-B27P27, Ti-C60 and Cu-Si72 catalysts. Journal of Molecular Modeling, 30(3), 1-11.

Ibraheem, K. J. (2018). Clinical Study Of Enteropathogenic Which Causes Diarrhea Among 0-15 Years Age Group In Baghdad City. Journal of Basic Education College-Mustansiriya University, 24(100), 18-25.

Ibraheem, M. R.(2008). Study on prevalence of Entamoeba histolytica among children in Kirkuk city and the efficiency of some chemotherapeutic drugs and medicinal herbs extracts in vitro culture. Master Thesis. College of Science. University of Tikrit.

Immunology of parasitic helminth infections. Infection and Immunity, 7.

Immunology of parasitic helminth infections. Infection and Immunity, 7.

Ismail, A. M. (2006). Diagnostic study of Entamoeba histolytica/ Entamoeba dispar and its relation with pathogenic bacteria causing diarrhea in children. Ph. D. Thesis, College of Medicine, Tikrit University.

Jalal, B. J., & Alqaisi, M. R. M. (2024). Improving the production and quality of white button mushroom (Agaricus bisporus) by adding biochar and ash to the casing layer. Tikrit Journal for Agricultural Sciences, 24(1), 22–33. https://doi.org/10.25130/tjas.24.1.3.

Kabir, Tamanna, et al. "α-and β-Globin Gene Mutations in Individuals with Hemoglobinopathies in the Chattogram and Sylhet Regions of Bangladesh." Hemoglobin 47.1 (2023): 3-10.

Kadham, S. M., Mustafa, M. A., Abbass, N. K., & Karupusamy, S. (2024). IoT and artificial intelligence–based fuzzy-integral N-transform for sustainable groundwater management. Applied Geomatics, 16(1), 1-8.

Kadham, S. M., Mustafa, M. A., Abbass, N. K., & Karupusamy, S. (2023). Comparison between of fuzzy partial H-transform and fuzzy partial Laplace transform in x-ray images processing of acute interstitial pneumonia. International Journal of System Assurance Engineering and Management, 1-9.

Kadir, M. A., El-Yassin, S. T., & Ali, A. M. (2018). Detection of Entamoeba histolytica and Giardia lamblia in children with diarrhea in Tikrit city. Tikrit Journal of Pure Science, 23(6), 57-64.

Karim, K. K., & Abdulla, N. R. (2024). Use of various sources of calcium in the diets of broiler and its effects on carcass and some meat quality. Tikrit Journal for Agricultural Sciences, 24(1), 45–56. https://doi.org/10.25130/tjas.24.1.5.

Kurt Z., Jorge L., Yura M., Maria L., et al. (2007). Effect of Vitamin A and Zinc Supplementation on Gastrointestinal Parasitic Infections among Mexican Children. Pediat. ;(120), 554-846.

Lee, Na Kyeong, Seongeon Cho, and In-San Kim. "Ferritin–a multifaceted protein scaffold for biotherapeutics." Experimental & molecular medicine 54.10 (2022): 1652-1657.

Lu, Z. F., Hsu, C. Y., Younis, N. K., Mustafa, M. A., Matveeva, E. A., Al-Juboory, Y. H. O., ... & Abdulraheem, M. N. (2024). Exploring the significance of microbiota metabolites in rheumatoid arthritis: uncovering their contribution from disease development to biomarker potential. APMIS.

MacDonald, A .S. Araujo. M. I. & Pearce, E. J. (2002).

Mahmoud, Z. H., Ajaj, Y., Hussein, A. M., Al-Salman, H. N. K., Mustafa, M. A., Kadhum, E. H., ... & Kianfar, E. (2024). CdIn2Se4@ chitosan heterojunction nanocomposite with ultrahigh photocatalytic activity under sunlight driven photodegradation of organic pollutants. International Journal of Biological Macromolecules, 267, 131465.

Mehlhorn, H. (2016). Human Parasites. Springer International Publishing.

Meri, M. A., Ibrahim, M. D., Al-Hakeem, A. H., & Mustafa, M. A. (2023). Procalcitonin and NLR Measurements in COVID-19 Patients. Latin American Journal of Pharmacy, 220-223.

Miller, Hannah W., Tammie SY Tam, and Katherine S. Ralston. "Entamoeba histolytica develops resistance to complement deposition and lysis after acquisition of human complement-regulatory proteins through trogocytosis." MBio 13.2 (2022): e03163-21.

Mitchell, Piers D., et al. "Giardia duodenalis and dysentery in Iron Age Jerusalem (7th–6th century BCE)." Parasitology (2023): 1-7.

Mora-Galindo, J.; Anaya-Velazquez, F.; Ramirez-Romo, S. & Gonzalez-Robles, A. (2004). Entamoeba histolytica: correlation of assessment methods to measure erythrocyte digestion, and effect of cysteine proteinases inhibitors in HM-1: IMSS and HK-9: NIH strains. Experimental Parasitology, 108: 98-100.

Mustafa, M. A., & Othman, S. A. (2024). Effect of adding natural and synthetic antioxidants to broiler drinking water as antistressor on productivity, antioxidant statues and hematological traits under heat stress. Tikrit Journal for Agricultural Sciences, 24(1), 94–104. https://doi.org/10.25130/tjas.24.1.9.

Mustafa, M. A., Kadham, S. M., Abbass, N. K., Karupusamy, S., Jasim, H. Y., Alreda, B. A., & Ahmed, M. T. (2024). A novel fuzzy M-transform technique for sustainable ground water level prediction. Applied Geomatics, 16(1), 9-15.

Mustafa, M. A., Raja, S., Asadi, L. A. A., Jamadon, N. H., Rajeswari, N., & Kumar, A. P. (2023). A Decision-Making Carbon Reinforced Material Selection Model for Composite Polymers in Pipeline Applications. Advances in Polymer Technology, 2023(1), 6344193.

Nozaki, T. & Nakada-Tsukui, K. (2006). Membrane trafficking as a Virulence mechanism of the enteric protozoan parasite Entamoeba histolytica. Parasitology Research, 98 (3): 179-183.

Pereira, V. V.; Conceicao, A. D. S.; Maximiano, L. H. S.; Belligoli, L. Q. G.; andSilva, E. S. D.;(2014). Laboratory diagnosis of amebiasis in a sample of student from southeastern Brazil and a comparison of microscopy with enzyme=linked immunosorbent assay for screening of infection with Entamoeba sp. Revista da Sociedade Brasileira de Medicina Tropical.47(1):52-56.

Roberts, L. S., Janovy, J., and Schmidt, G. D, Nadler,S. (2013). Foundation of parasitology. 9thed. McGraw-Hill companies, London.

Roberts, Nicholas, et al. "The global need and availability of blood products: a modelling study." The Lancet Haematology 6.12 (2019): e606-e615.

Russell, Clark D., et al. "The utility of peripheral blood leucocyte ratios as biomarkers in infectious diseases: A systematic review and meta-analysis." Journal of Infection 78.5 (2019): 339-348.

Saadh, M. J., Avecilla, F. R. B., Mustafa, M. A., Kumar, A., Kaur, I., Alawayde, Y. M., & Elmasry, Y. (2024). The promising role of doped h-BANDs for solar cells application: A DFT study. Journal of Photochemistry and Photobiology A: Chemistry, 451, 115499.

Saadh, M. J., Mustafa, M. A., Hussein, N. M., Bansal, P., Kaur, H., Alubiady, M. H. S., & Margarian, S. (2024). Investigating the ability of BC2N nanotube to removal Eriochrome blue black from wastewater: A computational approach. Inorganic Chemistry Communications, 163, 112311.

Salata, R. A.; Pearson, R. D. & Ravdin, J. I. (1985). Interaction of human leukocytes and Entamoeba histolytica. Journal of Clinical Investigation, 76: 491-499.

Satoskar, A. R.; Simon, G. L.; Hotez, P. J. & Tsuji, M. (2009).Medical parasitology. Landes Bioscience, Austin: 296 pp.

Selberherr, E., et al. "The life cycle-dependent transcriptional profile of the obligate intracellular amoeba symbiont Amoebophilus asiaticus." FEMS Microbiology Ecology 98.1 (2022): fiac001.

Shakir, O. M., Abdulla, K. K., Mustafa, A. A., & Mustafa, M. A. (2019). Investigation of the presence of parasites that contaminate some fruits and vegetables in the Samarra City in Iraq. Plant Arch, 19, 1184-1190.

Shin, Jisoo, et al. "Ferritin Nanoshuttle for Long-Lasting Self-Healing of Phenolic Hydrogels." Nano Letters (2023).

Slater, Hannah C., et al. "The temporal dynamics and infectiousness of subpatent Plasmodium falciparum infections in relation to parasite density." Nature communications 10.1 (2019): 1433.

Teixeira, J.E.; Heron, B.T. and Huston,S.E.(2008). CD. C1q- and collectin-dependent phagocytosis of apoptotic host cells by the intestinal protozoan Entamoeba histolytica. Journal of Infectious Diseases. 198(7):1062–1070.

Valluru, D., Mustafa, M. A., Jasim, H. Y., Srikanth, K., RajaRao, M. V. L. N., & Sreedhar, P. S. S. (2023, March). An Efficient Class Room Teaching Learning Method Using Augmented Reality. In 2023 9th International Conference on Advanced Computing and Communication Systems (ICACCS) (Vol. 1, pp. 300-303). IEEE.

Wesel, J.; Shuman, J.; Bastuzel, I.; Dickerson, J. and Ingram-Smith, C. (2021). Encystation of Entamoeba histolytica in Axenic Culture. Microorganisms, 9(4), 873.

WHO. (1991). Basic Laboratory Methods in Medical Parasitology: microscopic examination of wet mounts Geneva: 10-4P.

Yaseen, A. H., Khalaf, A. T., & Mustafa, M. A. (2023). Lung cancer data analysis for finding gene expression. Afr. J. Biol. Sci, 5(3), 119-130.

Yoshida, Tatsuro, Michel Prudent, and Angelo D'Alessandro. "Red blood cell storage lesion: causes and potential clinical consequences." Blood Transfusion 17.1 (2019): 27.

Zeki, Israa Naif, and Harith Saeed Al-Warid. "The prevalence of anemia among children infected with Entamoeba histolytica in Baghdad." Iraqi Journal of Science (2019): 2590-2599.