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# مجلة الشمال

للعلوم

الأساسية والتطبيقية

دورية علمية محكمة

جامعة الحدود الشمالية

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# مجلة الشمال للعلوم الأساسية والتطبيقية (JNBAS)

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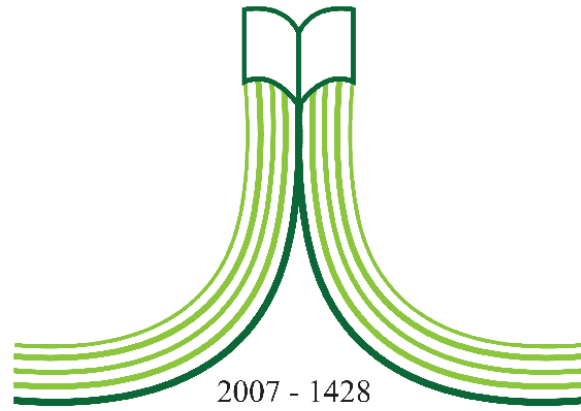
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# مجلة الشمال للعلوم الأساسية والتطبيقية (JNBAS)

دورية علمية محكمة

تصدر عن

مركز النشر العلمي والتأليف والترجمة  
جامعة الحدود الشمالية

المجلد السادس – العدد الثاني

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# مجلة الشمال للعلوم الأساسية والتطبيقية (JNBAS)

## التعريف بالمجلة

تعنى المجلة بنشر البحوث والدراسات العلمية الأصلية في مجال العلوم الأساسية والتطبيقية، باللغتين العربية والإنجليزية، كما تهتم بنشر جميع ما له علاقة بعرض الكتب ومراجعتها أو ترجمتها، وملخصات الرسائل العلمية، وتقارير المؤتمرات والندوات العلمية، وتصدر مرتين في السنة (مايو - نوفمبر).

## الرؤية

الريادة في نشر البحوث العلمية المحكمة، وتصنيف المجلة ضمن أشهر الدوريات العلمية العالمية.

## الرسالة

نشر البحوث العلمية المحكمة في مجال العلوم الأساسية والتطبيقية وفق معايير عالمية متميزة.

## أهداف المجلة

- (1) أن تكون المجلة مرجعاً علمياً للباحثين في العلوم الأساسية والتطبيقية.
- (2) تلبية حاجة الباحثين إلى نشر بحوثهم العلمية، وإبراز جهوداتهم البحثية على المستويات المحلية والإقليمية والعالمية.
- (3) المشاركة في بناء مجتمع المعرفة بنشر البحوث الرصينة التي تؤدي إلى تنمية المجتمع.
- (4) تغطية أعمال المؤتمرات العلمية المحكمة.

## شروط قبول البحث

- (1) الأصالة والابتكار وسلامة المنهج والاتجاه.
- (2) الالتزام بالمناهج والأدوات والوسائل العلمية المتبعة في مجاله.
- (3) الدقة في التوثيق والمصادر والمراجع والتخريج.
- (4) سلامة اللغة.
- (5) أن يكون البحث غير منشور أو مقدم للنشر في أي مكان آخر.
- (6) أن يكون البحث المستل من الرسائل العلمية غير منشور أو مقدم للنشر، وأن يشير الباحث إلى أنه مستل.

## الإشتراك والتبادل

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# شروط النشر

## أولاً: ضوابط النص المقدم للنشر

- (1) ألا تزيد صفحاته عن (35) صفحة من القطع العادي (A4).
- (2) أن يحتوي على عنوان البحث وملخصه باللغتين العربية والإنجليزية في صفحة واحدة، بحيث لا يزيد عن (250) كلمة للملخص، وأن يتضمن البحث كلمات مفتاحية دالة على التخصص الدقيق للبحث باللغتين، بحيث لا يتجاوز عددها (6) كلمات، توضع بعد نهاية كل ملخص.
- (3) أن يذكر اسم المؤلف وجهة عمله بعد عنوان البحث مباشرة باللغتين العربية والإنجليزية.
- (4) أن تقدم البحوث العربية مطبوعة بخط (Simplified Arabic)، بحجم (14) للنصوص في المتن، وبالخط نفسه بحجم (12) للهوامش.
- (5) أن تقدم البحوث الإنجليزية مطبوعة بخط (Times New Roman) بحجم (12) للنصوص في المتن، وبالخط نفسه بحجم (9) للهوامش.
- (6) كتابة البحث على وجه واحد من الصفحة، مع ترك مسافة سطر واحد بين السطور، وتكون الحواشي 2.5 سم على الجوانب الأربعة للصفحة، بما يعادل 1.00 إنش (بوصة).
- (7) التزام الترتيب الموضوعي الآتي:  
**المقدمة:** تكون دالة على موضوع البحث، والهدف منه، ومنسجمة مع ما يرد في البحث من معلومات وأفكار وحقائق علمية، كما تشير باختصار إلى مشكلة البحث، وأهمية الدراسات السابقة.  
**العرض:** يتضمن التفاصيل الأساسية لمنهجية البحث، والأدوات والطرق التي تخدم الهدف، وترتب المعلومات حسب أولويتها.  
**النتائج والمناقشة:** يجب أن تكون واضحة موجزة، مع بيان دلالاتها دون تكرار.  
**الخاتمة:** تتضمن تلخيصاً موجزاً للموضوع، وما توصل إليه الباحث من نتائج، مع ذكر التوصيات والمقترحات.
- (8) أن تدرج الرسوم البيانية والأشكال التوضيحية في النص، وترقم ترقيماً متسلسلاً، وتكتب أسماؤها والملاحظات التوضيحية أسفلها.
- (9) أن تدرج الجداول في النص، وترقم ترقيماً متسلسلاً، وتكتب أسماؤها أعلاها، وأما الملاحظات التوضيحية فتكتب أسفل الجدول.
- (10) ألا توضع الهوامش أسفل الصفحة إلا عند الضرورة فقط، ويشار إليها برقم أو نجمة، ويكون الخط فيها بحجم (12) للعربي و (9) للإنجليزي.
- (11) لا تنشر المجلة أدوات البحث والقياس، وتقوم بحذفها عند طباعة المجلة.
- (12) أن يُراعى في منهج توثيق المصادر والمراجع داخل النص نظام (APA)، وهو نظام يعتمد ذكر الاسم والتاريخ (name/year) داخل المتن، ولا يقبل نظام ترقيم المراجع داخل النص مع وضع الحاشية أسفل الصفحة، وتوضع المصادر والمراجع داخل المتن بين قوسين حسب الأمثلة الآتية: يذكر اسم عائلة المؤلف متبوعاً بفاصلة، فسنة النشر، مثلاً: (مجاهد، 1988م). وفي حالة الاقتباس المباشر يضاف رقم الصفحة مباشرة بعد تاريخ النشر مثلاً: (خيري، 1985م، ص:33). أما إذا كان للمصدر مؤلفان فيذكران مع اتباع الخطوات السابقة مثلاً: (الفالح وعياش، 1424هـ). وفي حالة وجود أكثر من مؤلفين فتذكر أسماء عوائلهم أول مرة، مثلاً: (مجاهد والعودات والشيخ، 1408هـ)، وإذا تكرر الاقتباس من المصدر نفسه فيشار إلى اسم عائلة المؤلف الأول فقط، ويكتب بعده وآخرون مثل: (مجاهد وآخرون، 1408هـ)، على أن تكتب معلومات النشر كاملة في قائمة المصادر والمراجع.
- (13) تخرج الأحاديث والآثار على النحو الآتي:  
(صحيح البخاري، ج:1، ص:5، رقم الحديث 511).
- (14) توضع قائمة المصادر والمراجع في نهاية البحث مرتبة ترتيباً هجائياً حسب اسم العائلة، ووفق نظام جمعية علم النفس الأمريكية (APA) الإصدار السادس، وبحجم (12) للعربي و(9) للإنجليزي، وترتب البيانات الببليوغرافية على النحو الآتي:

### • الاقتباس من كتاب لمؤلف واحد:

الخوجلي، أحمد. (2004م). *مبادئ فيزياء الجوامد*. الخرطوم، السودان: عزة للنشر والتوزيع.

- **الاقتباس من كتاب لأكثر من مؤلف:**  
نيوباي، تيموثي؛ ستيبتش، دونالد؛ راس، جيمس. (1434هـ/2013م). *التقنية التعليمية للتعليم والتعلم*. الرياض، المملكة العربية السعودية: دار جامعة الملك سعود للنشر.
- **الاقتباس من دورية:**  
النافع، عبداللطيف حمود. (1427هـ). أثر قيادة السيارات خارج الطرق المعبدة في الغطاء النباتي بالمنزهات البرية: دراسة في حماية البيئة، في وسط المملكة العربية السعودية. *المجلة السعودية في علوم الحياة*، 14 (1)، 53-72.
- **الاقتباس من رسالة ماجستير أو دكتوراه:**  
القاضي، إيمان عبدالله. (1429هـ). *النباتات الطبيعية للبيئة الساحلية بين رأسي تنورة والملوح بالمنطقة الشرقية: دراسة في الجغرافيا النباتية وحماية البيئة*. رسالة دكتوراه غير منشورة، كلية الآداب للبنات، الدمام؛ المملكة العربية السعودية: جامعة الملك فيصل.
- **الاقتباس من الشبكة العنكبوتية (الإنترنت):**  
- **الاقتباس من كتاب:**  
المزروع—ي، م.ر. و المدني، م.ف. (2010م). *تقييم الأداء في مؤسسات التعليم العالي*. المعرف الرقمي (DOI:10.xxxx/xxxx-xxxxxxx-x)، أو برتوكول نقل النصوص التشعبي (<http://www...>)، أو الرقم المعياري الدولي للكتاب (ISBN : 000-0-00 - 000000-0)
- **الاقتباس من مقالة في دورية:**  
المدني، م.ف. (2014). مفهوم الحوار في تقريب وجهات النظر. *المجلة البريطانية لتكنولوجيا التعليم*، 11 (6)، 260-225. المعرف الرقمي (DOI:10.xxxx/xxxx-xxxxxxx-x) أو برتوكول نقل النصوص التشعبي (<http://www...>) (ISSN: 1467 - المجلة - الدولي للرقم المعياري التسلسلي الدولي للمجلة - 8535)
- 15) يلتزم الباحث بترجمة (أو رومنة) أسماء المصادر والمراجع العربية إلى اللغة الإنجليزية في قائمة المصادر والمراجع. وعلى سبيل المثال:  
الجبر، سليمان. (1991م). تقويم طرق تدريس الجغرافيا ومدى اختلافها باختلاف خبرات المدرسين وجنسياتهم وتخصصاتهم في المرحلة المتوسطة بالمملكة العربية السعودية. *مجلة جامعة الملك سعود- العلوم التربوية*، 3 (1)، 170-143.
- Al-Gabr, S. (1991). The Evaluation of Geography Instruction and the Variety of its Teaching Concerning the Experience, Nationality, and the Field of Study in Intermediate Schools in Saudi Arabia (*in Arabic*). *Journal of King Saud University- Educational Sciences*, 3(1), 143-170.
- 16) تستخدم الأرقام العربية الأصلية (0، 1، 2، 3، ...) في البحث.
- 17) تؤول جميع حقوق النشر للمجلة في حال إرسال البحث للتحكيم وقبوله للنشر.

## ثانياً: الأشياء المطلوب تسليمها

- 1) نسخة إلكترونية من البحث بصيغتي (WORD) و (PDF)، وترسلان على البريد الإلكتروني الآتي:  
[s.journal@nbu.edu.sa](mailto:s.journal@nbu.edu.sa) & [s.journal.nbu@gmail.com](mailto:s.journal.nbu@gmail.com)
- 2) السيرة الذاتية للباحث، متضمنة اسمه باللغتين العربية والإنجليزية، وعنوان البريد الإلكتروني الحالي، ورتبته العلمية.
- 3) تعبئة النماذج الآتية:
  - أ - نموذج طلب نشر بحث في المجلة.
  - ب - نموذج تعهد بأن البحث غير منشور أو مقدم للنشر في مكان آخر.

## ثالثاً: تنبيهات عامة

- 1) أصول البحث التي تصل إلى المجلة لا تردّ سواء نُشِرَتْ أم لم تنشر.
- 2) الآراء الواردة في البحوث المنشورة تعبر عن وجهة نظر أصحابها.



## المحتويات

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while visiting farmhouse or barn areas where the virus may be potentially circulating among camels. It highlights the importance of studies that need to be done to find out the infectivity rate of camels by COVID-19. People also need to be educated and cautioned about adhering to follow the regular sanitation precautions, like frequent hand cleansing when they come in contact with animals. Awareness and knowledge about food hygiene are also equally important. Since not many studies have taken place in this area, however people need to be advised, not to eat camel meat and also not to drink camel milk or urine, which some people use for its medicinal importance. Awareness should be created that COVID -19 and MERS-CoV are from the same family of coronaviruses; it is noteworthy that since coronavirus had infected the camels in the Middle-East causing many deaths, research is needed to exclude whether COVID-19 can cause infection in camel. Measures need to be taken to protect camels and save them as they are the heritage of Middle East countries and also protect the nationals in-case spread is possible through camel-human transmission or vice versa.

### **Conclusion:**

The Covid-19 pandemic has become a major health scourge. Absent a simple cure the emphasis on prevention is most relevant. Mortality can be decreased by an improved understanding of the consequences of viral infection. There is a necessity for a health education program to be started at every level by health authorities; moreover, Awareness should be spread regarding control measures to be adopted to prevent coronavirus infection. If people, who get infected with the coronavirus, can be identified in an initial phase of illness and they are told to do isolation together with proper treatment and management of such cases can help in their recovery and spread of further infection to others.

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with the real virus when confronted later. Many pharmaceutical companies are trying to make a vaccine.

Vaccines recommended and approved by different Health Organizations for COVID-19 are as follows.

- Vaccine for COVID-19 by Pfizer-BioNTech
- Vaccine for COVID-19 by Moderna's
- Vaccine for COVID-19 by AstraZeneca's
- Vaccine for COVID-19 by Johnson's and Johnson's

**Indications and vaccine selection** - the COVID-19 mRNA vaccines BNT162b2 (Pfizer-BioNTech COVID-19 vaccine) and mRNA-1273 (Moderna COVID-19 vaccine) and the adenoviral vector vaccine Ad26.COV2.S (Janssen COVID-19 vaccine, also referred to as the Johnson & Johnson vaccine) is recommended as follows:

- BNT162b2 (Pfizer-BioNTech COVID-19 vaccine) is indicated for individuals aged 12 years or older.
- mRNA-1273 (Moderna COVID-19 vaccine) is indicated for individuals aged 18 years or older.
- Ad26.COV2.S (Janssen COVID-19 vaccine) is indicated for individuals aged 18 years or older.

#### **Advantage and disadvantage of approved available SARS-CoV-2 vaccines**

##### **1.RNA or mRNA VACCINE**

Vaccines include: Pfizer-BioNTech, and Moderna  
Number of doses required: 2 doses, intramuscular  
The COVID-19 RNA vaccine consists of mRNA molecules that code for parts of the SARS-CoV-2 virus – specifically the virus' spike protein.

Once injected into the body, the mRNA instructs the cells to produce antigens – such as the spike protein – which are then detected by immune cells, triggering a response by the body's lymphocytes.

Advantage: Include good safety (since there are no live components, there's no risk of the vaccine triggering disease), reliability, and these vaccines can be quickly designed based on genetic sequencing alone.

Disadvantage: Unintended effects (such as an unintended immune reaction), ensuring effective delivery into the body (since free RNA in the body is quickly broken down), storage issues, plus there is a theoretical probability vaccine DNA can integrate into the genome.

##### **2.NON-REPLICATING VIRAL VECTOR**

Vaccines include: Oxford-AstraZeneca, Sputnik V (Gamaleya Research Institute) and Johnson & Johnson vaccine

Number of doses required: 2 doses, intramuscular.  
Johnson & Johnson vaccine (Single dose).

This type of vaccine introduces a safe, modified version of the virus – known as “the vector” – to deliver genetic code for the antigen. In a COVID-19 vaccine, the vector is the spike proteins found on the surface of the coronavirus.

Once the body's cells are “infected”, the cells are instructed to produce a large number of antigens, which in turn trigger an immune response.

Advantage: Viral vector-based vaccines can trigger a strong immune response as it also involves both B cells and T cells. It has a highly specific delivery of antigens to target cells and high expression of antigen after vaccination

Disadvantage: Previous exposure to the vector could reduce effectiveness, plus these types of vaccines are relatively complex to manufacture compared to others.

##### **Role of camels in Coronavirus transmission in the Middle East:**

Camels in the Gulf region were found to be infected with MERS-CoV in the past. COVID-19 belongs to the family of MERS-CoV, hence research needs to be done if the COVID-19 infect camels also as it has been found to infect few animals already. So far the adequate research on camels getting infected by COVID-19 which in turn can cause infection to humans is not clear. Infections with the coronavirus can be severe in people with diabetes, chronic lung disease, immune-compromised persons & renal failure. These special group people should be warned to avoid close contact with camels, particularly

(Dexamethasone/Methylprednisolone), Enoxaparin (Anticoagulant Heparin) and Vitamin C (Nile, Qiu, Li, Jia & Kai 2020)

Moreover, the use of Favipiravir (FPV) in COVID-19 showed an improved recovery rate and better response to treatment, management, prognosis, and viral clearance (Cai, *et al.*, 2020).

◆ **Patients With Mild to Moderate COVID-19 Who Are Not Hospitalized**

• **Recommendations**

For patients who are not at high risk of disease progression: it is recommended to give supportive care and symptomatic management. For patients who are at high risk of disease progression for treatment with anti-SARS-CoV-2 monoclonal antibodies, it is recommended to use one of the following combination anti-SARS-CoV-2 monoclonal antibodies (treatments are listed in alphabetical order):

Bamlanivimab 700 mg plus Etesevimab 1,400 mg; *or* Casirivimab 1,200 mg plus Imdevimab 1,200 mg .

Treatment should be started as soon as possible after the patient receives a positive result on a SARS-CoV-2 antigen test or a nucleic acid amplification test and within 10 days of symptom onset.

◆ **Patients Who Are Hospitalized With Moderate COVID-19 but Who Do Not Require Supplemental Oxygen**

• **Recommendations**

It is recommended against the use of dexamethasone or other corticosteroids. Patients who are receiving dexamethasone or another corticosteroid for other indications should continue therapy for their underlying conditions as directed by their health care provider.

The routine use of remdesivir in these patients is not recommended. The use of remdesivir may be appropriate in patients who have a high risk of disease progression.

**For Hospitalized Patients With COVID-19 Who Require Supplemental Oxygen and Who Do Not Require Oxygen Delivery Through a High-Flow Device, Noninvasive Ventilation, Invasive Mechanical Ventilation, or Extracorporeal Membrane Oxygenation Recommendations**

The following options for these patients are recommended:

Remdesivir (e.g., for patients who require minimal supplemental oxygen) ;

Dexamethasone plus Remdesivir (e.g., for patients who require increasing amounts of oxygen); *or*

**Dexamethasone** (e.g., when combination therapy with remdesivir cannot be used or is not available)

◆ **For Hospitalized Patients With COVID-19 Who Require Delivery of Oxygen Through a High-Flow Device or Noninvasive Ventilation but Not Invasive Mechanical Ventilation or Extracorporeal Membrane Oxygenation**

• **Recommendations**

One of the following options for these patients is recommended: Dexamethasone alone; *or*; a combination of Dexamethasone plus Remdesivir. For patients who were recently hospitalized and who have rapidly increased oxygen needs and systemic inflammation, add Tocilizumab to one of the two options above.

◆ **For Hospitalized Patients With COVID-19 Who Require Invasive Mechanical Ventilation or Extracorporeal Membrane Oxygenation**

◆ **Recommendations**

It is recommended to use dexamethasone in hospitalized patients with COVID-19 who require invasive mechanical ventilation.

**Vaccines:** Antigen-presenting cells bind with inoculated virus and present it to the T helper and B cells, which in turn harvest antibodies that deal



**Complications:** There are two structures mainly involved in Covid-19 infection: A) Pulmonary Complications B) Extrapulmonary complications.

**Pulmonary complications:** Pneumonia, ARDS, multiple-system and multi-organ failure (Song, Li, Xie, Hou, & You, 2020) and leukocytosis (Mehta, McAuley, Brown, Sanchez, Tattersall, Manson, 2020). Vascular thrombosis – Intra alveolar fibrin deposition, fibrin thrombi, and microangiopathy (Katzenstein, Bloor & Leibow, 1976). DIC and large-vessel thrombosis (Barton, Duval, Stroberg, Ghosh & Mukhopadhyay, 2020).

**Extrapulmonary complications:**

Deep vein thrombosis, acute pulmonary embolism, thromboembolism, and catheter-induced thrombosis. Cardiac complications such as myocarditis, ischemia, cardiomyopathy, arrhythmias, and cardiogenic shock. Endocrine: Hyperglycaemias and diabetic ketoacidosis. Dermatological: Petichiae, urticarial and livedo reticularis. Neurologic: Aguesia, anosmia, stroke, Guillain-Barre syndrome, headache, and dizziness. Renal: Acute kidney injury, proteinuria, and haematuria. Hepatic: Elevated transaminases and bilirubin GI Tract: Diarrhea, vomiting, anorexia, and abdominal pain (Gupta, Madhavan, Sehgal, Nair, Mahajan, Sehrawat, Bikdeli, Ahluwalia, Ausiello, Wan, Freedberg, Kirtane, Parikh, Maurer Nordvig, Accili, Bathon, Mohan, Bauer, Leon, Landry, 2020).

### COVID-19 Treatment Guidelines

Early in the clinical course, the disease is due to replication of SARS-CoV-2. Later the disease is driven by a dysregulated immune/inflammatory response to SARS-CoV-2 that leads to tissue damage. Therefore antiviral therapies have the greatest effect early in the course of the disease, while immunosuppressive/anti-inflammatory therapies are likely to be more beneficial in the later stages of COVID-19.

◆ **Important points related to treatment guidelines are as follows:**

- Drugs to prevent the entrance of the Virus into the Cell: Hydroxychloroquine (Hogan, Jewell, Smith, Vesga, Watson, Whittaker, Hallett, Hamlet, Smith, Ainslie, K., Baguelin,

Bhatt, Boonyasiri, Brazeau, Cattarino, Charles, Cooper, Coupland, Gina Cuomo-Dannenburg, Dighe & Timothy, 2020).

- For Viral load reduction: Remdesivir and/or Azithromycin. Remdesivir may be considered in patients with moderate disease for those on oxygen (Cai, Yang, Liu, Chen, Shu, Xia, Liao, Gu, Cai, Yang, Shen, Li, Peng, Huang, Zhang, Zhang, Wang, Liu, Chen, Liu, 2020).
- Reduce Hyper Immune Response Compounding Hypoxia: (Glucocorticoids, Tocilizumab (IL-6 Inhibitor) 4 and/or Favipiravir (Kevin, 2020).
- Anti-SARS-CoV-2: Antibody-based therapies have the utmost potential for a clinical benefit during the earliest stages of infection. For these patients, it is recommended to administer Bamlanivimab plus Etesevimab or Casirivimab plus imdevimab.
- Remdesivir, an antiviral agent, is recommended for use in hospitalized patients who require supplemental oxygen for the treatment of COVID-19.
- Dexamethasone, a corticosteroid, has been found to improve survival in hospitalized patients who require supplemental oxygen, with the utmost benefit observed in patients who require mechanical ventilation.
- Adding Tocilizumab, a recombinant humanized anti-interleukin-6 receptor monoclonal antibody, to Dexamethasone therapy was found to advance survival among patients who were exhibiting rapid respiratory decompensation due to COVID-19.

◆ **Prevention and Treatment in the different phases of COVID-19 illness**

**Prevention:** Social distancing (2 meters), wearing the mask, frequent hand washes and use of hand sanitizers.

**Treatment different Phases of Illness:** I. Early infection: Symptomatic, Hydroxychloroquine (HCQ), Ivermectin and Azithromycin (Clinical management protocol: COVID-19, 2020).

II. Pulmonary: Early and Late: Corticosteroids (Dexamethasone/Methylprednisolone), Enoxaparin, Remdesivir and Vitamin C.

III Hyperinflammation phase: Corticosteroids

- **Advanced/alternative (POCT) approaches:**
    - A number of point of care (POCT) kits are available based on IgM or IgG, and ELISA for COVID-19 showing higher detection rates. ELISA-based detection kits use antibodies against spike, nucleocapsid, or membrane and envelope proteins and are considered as one of the most sensitive methods for COVID-19 diagnosis. POCT as the name indicates can be used at the patient’s bedside with ease without any experts or trained persons to operate. The handheld POCTs are of great importance in medical diagnostics which includes various types of biosensors.
  - **Biosensor**
    - A biosensor is a self-contained integrated analytical device consisting of the bioreceptor, transducer, and signal detector. Biosensors help in the development of portable devices for sensitive, specific, and quick diagnosis of disease in a cost-effective way. They use various diagnostics principles, such as PCR involving RNA or DNA sequences, gel electrophoresis, ELISA also called sandwich assay involving the interaction of antigen antibodies, and other detection procedures coupled with fluorescent and/or radioactive labeling.
  - **Aptamer based nano-biosensor**
    - Aptamers are being used as novel diagnostics tools. It consists of oligonucleotides of nucleic acids or even small peptide molecules. These molecules can be any membrane protein, amino acids, toxins, immunoglobulins, cytokines, growth factors, coupling agents, ionic metals, intact cells, or other small molecules. Aptamers can specially be designed and synthesized for the SARS-CoV-2, using its nucleocapsid protein to obtain fast test results within few seconds only, and without any sample preparation step.
  - **Paper-based detection:**
    - The paper-based technology can act as an alternative detection tool for rapid tracing for the source or presence of causative agents like COVID-19. It can trace the COVID-19 transmission in community wastewater by analyzing SARS-CoV-2 in feces, urine, and other excreted output of humans.
- Diagnosis:** Antigen test - PCR for viral RNA and Antibody tests – IgM and IgG. PCR positivity shows the presence of viral RNA. In the early phase, it indicates an active infection. Antibody tests serve as tools of surveillance. Used in conjunction with a clinical scenario and the PCR test, they help in the identification of the stage of infection and recovery as follow:

**Table 4: Interpretation of PCR findings in Covid-19 infection**

S, No	PCR for viral RNA and Antibody tests – IgM and IgG scenarios	Interpretation
1.	PCR+ IgM+ IgG-	An early phase of infection
2.	PCR+ IgM- IgG+	The active phase of infection
3.	PCR+ IgM- IgG-	Window period / Early stage of infection: Correlate clinically
4.	PCR- IgM- IgG-	An early phase of infection: PCR may be falsely negative
5.	PCR not done IgM+ IgG-	May be an early phase of infection – Get PCR done
6.	PCR not done IgM+ IgG+	The active phase of infection- Get PCR done
7.	PCR- IgM+ IgG+	The recovery phase of infection
8.	PCR- IgM- IgG+	Post Covid infection Recovery
9.	PCR- IgM+ IgG=	= Post Covid infection Recovery / False-negative Covid
10.	PCR- IgM- IgG-	Not infected / Early infection – Needs clinical correlation

\* Polymerase chain reaction (PCR) Immunoglobulin G (IgG), Immunoglobulin M (IgM) and Ribonucleic acid RNA

### Different approaches to diagnose Coronavirus :

Diagnostic methods available presently for virus detection have different degrees of specificity. These methods include imaging like CT, or viral nucleic acid-like RT-PCR using one or more genes, or next Generation Sequencing whole genome, immunological molecules produced by the patient or by the virus in the patient's body- Antigen-antibody reaction-based tests like enzyme-linked immunosorbent assay. There are other methods used in detecting the coronavirus that are described here.

- **Nucleic acid-based method:** Nucleic Acid-based technologies utilize genetic material such as DNA/RNA and are based on the principle of their highly specific base pairing with homologous strands. These technologies such as polymerase chain reaction (PCR), DNA microarrays, etc are the nucleic acid-based technologies test used for diagnostics of coronavirus.
- **Next-generation sequencing (NGS):** Next-generation sequencing (NGS) is also known as high-throughput sequencing (HTS). By this test, we can choose the genomic sequence, even more than one million base pairs in a single trial. NGS helps not only in finding novel viral strains on a large scale but also provides very speedy detection of these viruses which link with human diseases. The NGS technology along with bioinformatics tools have deeply influenced viral diagnostics. This technology has immense significance for identifying unknown pathogens, and mutation or recombination in the genome of the pathogen in a short span of time, but the huge cost of the equipment and chemicals required in this technique restricts its utilization in routine laboratory diagnosis of the diseases.
- **RT-PCR:** Quantitative reverse transcription-polymerase chain reaction (rRT-PCR) is being used for diagnosis of COVID-19 and is a gold standard molecular diagnostic technique for many viruses as well. Single-step quantitative RT-PCR is more sensitive and specific. It only

needs a specific primer-probe designed and synthesized. Every assay has a varying degree of sensitivity as there are a different set of genes used by manufacturers for SARS-CoV2 which include ORF-1a gene, ORF-1b gene, RdRp gene, N gene, E gene, etc.

- **Loop-mediated isothermal amplification (LAMP):**
  - It is a new method which is a molecular amplification technique that can augment any genomic material with high efficiency and in a shorter time. The technique is based on a synthesis of target DNA at a constant temperature of 60–65 °C using specially designed primer and enzyme (DNA polymerase). Using strand displacement activity instead of heat denaturation, as in other PCR techniques, in an hour or less time can augment the target sequence up to more than 10<sup>9</sup> copies.
- **Computed tomography (CT) scan:**
  - CT scan is also one of the diagnosis techniques having high sensitivity than PCR for iSARS-CoV-2 suspected persons. The results show that a more sensitive and accurate conclusion can be achieved using a combination of CT-scan and RT-qPCR or other sensitive diagnostic tests. The high-resolution CT is also proved as an essential tool for detection of SARS-CoV-2, at an early stage and to take a rapid and necessary intervention.
- **Antigen–antibody-based methods:** Serological-based testing methods in general use blood samples for detection of the virus instead of nasopharyngeal swab samples used in PCR test. The blood samples contain either a significant and measurable concentration of antibodies or virus-specific antigens. The blood test for COVID-19 detects the antigen/biomarkers or antibodies particular to the virus. Two types of COVID-19 tests have been reported one direct utilizing antigen based on detection of viral component present during the time of infection and the second indirect using antibodies that appear in patient's serum later due to development of immune response against the virus.

beginning, gradually decreases, and almost disappears by the end of the second stage. Conditions which may mimic Covid-19 (El-Kafrawy, Corman, Tolah, Al Masaudi,

Hassan, Müller, Bleicker, Harakeh, Alzahrani, Alsaaidi, Alagili, Hashem, Fabricant,1998) include the flu, common cold, and allergy.

**Table 2: COVID-19 patients are categorized into the following stages**

S.No	Stages	Characteristic features
1.	Asymptomatic	COVID nucleic acid test is positive. No clinical symptoms and signs and X-Ray Chest are normal.
2.	Mild	Symptoms of acute upper respiratory tract infection (fever, fatigue, myalgia, cough, sore throat, runny nose, sneezing) or digestive symptoms (nausea, vomiting, abdominal pain, diarrhea) are present.
3.	Moderate	Pneumonia with no obvious hypoxemia, Lesions are visible on Chest CT.
4.	Severe	Pneumonia with hypoxemia (SpO2 < 92%)
5.	Life-threatening (critical)	Acute Respiratory Distress Syndrome, Injury to the myocardium which may lead to failure of the heart, Encephalopathy, injury to the renal system & coagulation system abnormalities are detected.

Diagnosis of COVID-19 relies on epidemiological criteria like contact time within incubation period, presence of clinical symptoms, laboratory testing

and tests based on radiological imaging, etc (Varghese, John, Manesh, Karthik, & Abraham, 2020).

**Table 3: Co-infection among COVID-19 patients**

1.	<b>Bacteria</b>	<i>Staphylococcus aureus, Streptococcus pneumoniae, Legionella pneumophila, Klebsiella pneumoniae, Chlamydia pneumonia, Mycoplasma pneumoniae, and Acinetobacter baumannii;</i>
2.	<b>Fungus</b>	<i>Aspergillus flavus</i> and <i>Candida</i> species
3.	<b>Viruses</b>	Influenza A virus, influenza B virus, parainfluenza, enterovirus, rhinovirus, and human immunodeficiency virus. Influenza A is the most common co-infective viruses

After recognizing the possible pathogens causing co-infection among COVID-19 patients, appropriate treatment can be recommended.

coronavirus 1, Miniopterus bat coronavirus HKU8, porcine epidemic diarrhea virus, Rhinolophus bat coronavirus HKU2, Scotophilus bat coronavirus 512 .

**Beta coronavirus:** Beta coronavirus 1, human coronavirus HKU1, murine coronavirus, Pipistrellus bat coronavirus HKU5, Rousettus bat coronavirus HKU9, Severe acute respiratory syndrome-related coronavirus, Severe acute respiratory syndrome coronavirus 2, Tylonycteris bat coronavirus HKU4, MERS-CoV related coronavirus, human coronavirus OC43, hedgehog coronavirus 1 (EriCoV).

**Gamma coronavirus:** Infectious bronchitis virus (IBV), beluga whale coronavirus SW1 and infectious bronchitis virus

**Delta coronavirus:** Bulbul coronavirus HKU11 and porcine coronavirus HKU15.

### **Mechanism (Pathogenesis) of infection caused by Coronaviruses**

The disease is transmitted by droplet infection from the mouth and nose of a human being infected with the virus by sneezing or coughing (Wang, Hu, Zhu, Liu, Zhang Wang, Xiang Cheng, Xiong, Zhao, and Peng, 2020). The incubation period (IP) of COVID-19 is five to six days but maybe fourteen days. In the droplet, the virus can survive for 72 hours on plastic or steel surfaces and 24 hours on paper and cards (Hammett, 2020). SARSCoV2 remains hazardous in airborne droplets for a minimum of 3 hours (Forster, *et al.*, 2020). In the lung the virus binds with pneumocytes type II and results in viral replication, destroying the pneumocytes, and release inflammatory mediators like interleukins (IL-1 and IL6), and tissue necrosis factor (TNF)-alpha which causes edema in the lung (Perrier, Bonnin, Desmarests, Danneels, Goffard, Rouillé, Dubuisson & Belouzard, 2019). Consolidation of lung tissue happens as the disease progress, causing hypoxemia (Rothan & Byrareddy, 2020). The next complication that occurs in nearly 70% of COVID-19 infected patients is disseminated intravascular coagulation (DIC) causing multi-

system failure in human beings (Tang, Wang, & Sun, 2020). The cytokine-mediated peripheral vasodilatation results in low blood pressure which can cause multi-organ failure (Jin, Yang, Ji, Wu, Chen, Zhang, & Duan 2020).

The incubation period varies from one to fourteen days for infection with SARS-CoV-2. Symptoms develop faster in people 60 years and older. The virus attaches to receptors like hACE2, and the SARS-CoV-2 receptors present in the pneumocytes in the lung alveoli and causes stimulation of TNF $\alpha$  converting enzyme activity of metalloproteases. This enzyme further cleaves transmembrane from Angiotensin-Converting Enzyme-2 extracellular domain, resulting in its shedding. The main mechanism of infection with SARS-CoV-2 is the virus targets the respiratory system causing severe infection in the lung and the heart. Increased levels of cytokines in the blood of COVID-19 infection include Interferon-gamma (IFN $\gamma$ ), Tumor necrosis factor-alpha (TNF- $\alpha$ ), Vascular endothelial growth factor A (VEGF-A), interleukins 1- $\beta$ , interleukins 7, interleukins 8, interleukins 9, interleukins 10, and Fibroblast growth factor. Severe lung damage is considered markedly due to increased levels of cytokines found in patients with severe infections leading to clinical presentations explaining poor outcomes in such cases.

**Clinical features of COVID-19:** Most common clinical presentations of coronavirus disease are hyperpyrexia, cough, dyspnoea, myalgia and weakness. In addition to sore throat, nose black, malaise and headache. These symptoms' signifies infection is more severe and has associated organ failure (Huang, Hume, Abo, Werder, Villacorta-Martin, Alysandratos, Beermann, Simone-Roach, Olejnik, Suder, Bullitt, Hinds, Sharma, Bosmann, Wang, Hawkins, Burks, Saeed, Wilson, Mühlberger, Kotton, 2020). Covid-19 infection stages include (Siddiqi & Mehra 2020) the pulmonary phase which is due to viral effects and can produce various degrees of hypoxia depending upon the severity. The viral response is highest in the

a higher death rate than COVID-19. The death rate almost matched SARS and MERS -CoV in many countries. With the outbreak of COVID -19, WHO published high priority guidelines to prevent COVID-19 from spreading in the community. People were advised to stay safe, protected, maintain social distance, wear a mask, live in properly ventilated rooms, hand hygiene, and avoid crowds. WHO also issued guidelines regarding diagnosis, management and prevention of COVID-19. COVID guidelines are being followed all over the world now to prevent it spread in different countries (Hussain, Kaler, Tabrez, Tabrez, & Tabrez, 2020). Coronavirus family is huge and can cause diseases like the flu to diseases with higher modalities and mortalities like MERS-CoV and COVID-19 (Huang, Wang, Li, Ren, Zhao, Hu, Zhang, Fan, Xu, Gu, Cheng, Yu, Xia, Wei, Wu, Xie, Yin, Li, Liu, Xiao, Cao, 2020). COVID-19 also has indirect serious implications and may lead to mortality and death due to interference in the availability of other health care facilities for life-threatening diseases like HIV, cancer, stroke and myocardial infarctions, in addition to the death caused directly by COVID-19 (Unhale *et al.*, 2020).

### **Virology and epidemiology of Coronaviruses**

Corona is a Latin word meaning crown. The virus crown-like appearance is due to the presence of spike glycoproteins on the envelope (Voss, Kern, Traggiati, Eickmann, Stadler, Lanzavecchia, & Becker, 2006). It is a positive-stranded ribonucleic acid (RNA) virus comprising RNA of 27-32 kb size and being 80-160 nm diameter in size (Lai, 1990) and has a 5' covered structure and 3' poly-A tail (Chen, Liu & Guo, 2020). It has surface projections about 20 nm in length (van der Hoek, Pyrc, Jebbink, Vermeulen-Oost, Berkhout, Wolthers, Wertheim-van Dillen, Kaandorp, J., Spaargaren, J., & Berkhout, B. 2004). Spike protein, a type I glycoprotein present on the membrane, is associated with the infectivity of the virus (Voss *et al.*, 2006). The rapid mutation noticed in this virus is due to the spike proteins (Forster, P., Forster, L., Renfrew, & Forster, M. 2020).

The virus which now has a direct human to human spread initially was found to be spreading from animal to human. Though the transmission of viral

infection from animal to human is rare in COVID -19 the source of infection was found to be bats (Lei, Fan & Wang, 2020). The study of genes revealed the sources of alpha CoVs were bats and beta CoVs were rodents. The gene source of delta CoVs and gamma CoVs was found to be an avian species. These coronavirus families share a similar structure and the beta coronaviruses (beta CoVs) which had been responsible for huge epidemics have a close resemblance to the MERS-CoV virus. Both SARS-CoV and COVID-19 share an angiotensin-converting enzyme (ACE2) like receptor in the lungs resulting in common clinical presentation in the infected cases. Low variability of the novel coronavirus (2019-nCoV) highlighted two nucleotide positions of higher variability within protein coding regions, and specific amino acid divergences compared to bat coronavirus (BCoVs) and human severe acute respiratory syndrome (SARS), (Benvenuto, Giovanetti, Ciccozzi, Spoto, Angeletti, & Ciccozzi, 2020). These findings reflect the possibility of effective management for infection by the virus.

### **Classification of Coronaviruses and important pathogenic viruses associated with human and domestic animals.**

On the basis of genetic trees and partial nucleotide sequence of RNA-dependent RNA polymerase, *Coronavirinae* has been recognized and classified into four genera—alpha ( $\alpha$ ) coronavirus, beta ( $\beta$ ) coronavirus, gamma ( $\gamma$ ) coronavirus, and delta ( $\delta$ ) coronavirus. The  $\alpha$  coronaviruses and  $\beta$  coronaviruses infect only warm-blooded animals. The  $\gamma$  coronaviruses and  $\delta$  coronaviruses infect birds, but some of them can also infect mammals. Infection with  $\alpha$  coronaviruses and  $\beta$  coronaviruses leads to respiratory disorders in humans and gastrointestinal disorders in animals. Currently available genetic sequence databases of all human coronaviruses reveal with its animal origins: Domestic animals can act as an intermediate host to transmit these viruses from their reservoir host to humans. Sometimes the domestic animal may acquire infection with closely related zoonotic coronaviruses.

**Alpha coronavirus :** Human coronavirus 229E, human coronavirus NL63, *Miniopterus* bat

10.	<b>Bahrain</b>	102,626	372	98,160	4,094
11.	<b>Syria</b>	13,998	916	7,481	5,601
12.	<b>Yemen</b>	2,120	615	1,426	79
13.	<b>Iraq</b>	618,922	13,041	590,857	15,024
14.	<b>Turkey</b>	5,220,549	46,970	5,070,815	102,764
15.	<b>Egypt</b>	258,407	14,904	189,476	54,027
16.	<b>Israel</b>	641,373	4,768	567,208	69,397
		+2,584	+30		
17.	<b>Iran</b>	1,417,999	57,959	1,210,051	149,989
		+6,268	+70		

Common cold in many countries is caused by the coronavirus and also by a few other viruses namely enterovirus, influenza, adenovirus, parainfluenza, respiratory virus, and rhinovirus infecting the upper respiratory tract (Monto, Bryan, & Ohmit, 1987). The common source of upper respiratory tract infections in most age groups was a virus called Rhinoviruses (Monto *et al.*, 1987). In the past 20 years among the coronavirus diseases, COVID-19 is the third corona-virus disease to emerge in human beings. Table 2 shows interesting facts about Coronavirus.

### History of Coronavirus:

The emergence of the first report of coronavirus disease happened in the late 1920s in North America. It emerged as an acute respiratory infection of domesticated Chickens (Estola, 1970). In North Dakota, a new respiratory infection of chickens emerged in the year 1931. The newborn chicks had symptoms such as breathlessness and lethargy with high death rates of 40–90% (Fabricant 1998). Two more coronaviruses infecting animal was discovered namely mouse hepatitis virus and murine encephalitis in 1940 in Denver and Chicago which caused hepatitis in mice (McIntosh, 1974).

Human corona discovered in 1960 in the Chinese mainland could not be cultivated using procedures that had productively cultured other common cold viruses. Viruses were morphologically having similar shape and distinctive club-like spikes but still could not be cultivated using procedures which had productively cultured rhinoviruses and adenoviruses (Zhu Zhang, Wang, Li, Yang, Song, 2020). The emergence of other viruses of the corona family discovered in China includes severe respiratory syndrome (SARS-CoV) in 2003, MERS-CoV in 2013, and SARS-CoV-2 in 2020. Replication of HCoV is regulated by a diversity of host factors and induces drastic alterations in cellular structure and physiology (Unhale, Ansar, Sanap, Thakhre, Wadatkar, & Bairagi, 2020). World health organization (WHO ) confirmed COVID-19 to be a community health disaster and began spreading from Wuhan City in December of 2019. On January 5, 2020, the WHO announced this to be an epidemic affecting countries all over the world. On March 11, 2020, WHO declared the COVID-19 epidemic a pandemic, making the current coronavirus epidemic a global health threat. (Zakary, Rachik & Bidah, 2020). although SARS and MERS -CoV were found to have

positivity was found to be higher in local camels from Saudi Arabia (Hajjar, Memish, & McIntosh, 2013). It was noted trade at a large scale between Somalia and the Gulf regions caused multiple disease transmission (Hijawi, Abdallat, Sayaydeh, Alqasrawi, Haddadin, Jaarour, Alsheikh, & Alsanouri, 2013).

Aim: To review the MERS-CoV epidemic evolution in the Middle East Region.

### Coronavirus facts

In 2019, coronavirus infection originated in the city called Wuhan in China, spread all over the world and had been considered to be the most deadly viral disease. A report, published in 2021, showing the updated status of COVID-19 is given below in Table 1 (cite source). worldmeter.info (<https://www.worldmeters.info/coronavirus/#countries>) is given below in Table 1.

**Table 1: Updated status of COVID-19 as shown on worldmeters.info in USA, United Kingdom, and Middle East region.**

S.no	Name of places	Total number of cases	Total number of deaths	Total number of recovered cases	Total number of active cases
		Total number of new cases	Total number of new deaths		
1.	World	103,213,392	2,231,154	74,875,890	26,106,348
		+99,417	+3,254		
2.	USA	26,655,740	450,381	16,328,950	9,876,409
3.	UK	3,796,088	105,571	1,673,936	2,016,581
4.	Saudi Arabia	367,813	6,372	359,299	2,142
5.	UAE	303,609	850	276,958	25,801
		+2,948	+12		
6.	Kuwait	164,622	959	157,404	6,259
7.	Qatar	150,984	248	145,668	5,068
8.	Oman	134,326	1,529	126,854	5,943
		+598	+2		
9.	Lebanon	118,631	1,877	98,706	18,048
		+981	+35		



## Introduction:

The first respiratory infection in humans occurred in the nineteen-sixties by the human coronavirus (HCoVs), 229E and OC43 were some of the infections caused by HCoVs which were found to cause respiratory infections in humans. The surfacing of severe acute respiratory syndrome coronavirus (SARS-CoV) was seen to happen in 2002 but was found to have a low rate of infection (Zhong, Zheng, Li, Poon, Xie, Chan, Li, Tan, Chang, Xie, Liu, Xu, Yuen, Peiris & Guan, 2003). Within the previous 10 years, there have been two major outbreaks of coronavirus in Saudi Arabia. as well as in the Gulf region (Drosten, Günther, Preiser, Werf, Brodt, Becker, Rabenau, Panning, Kolesnikova, Fouchier, Berger, Burguière, Cinatl, Eickmann, Escriou, Grywna, Kramme, Manuguerra, Müller, Rickerts, Doerr, 2003). This first outbreak of coronavirus infection was due to zoonotic transmission from dromedary camels (Zhu, Zhang, Wang, Li, Yang, Song, Zhao, Huang, Shi, Lu, Niu, Zhan, Ma, Wang, Xu, Wu, Gao, Tan, 2019). It happened in 2012 and was called as Middle East Respiratory Syndrome-Corona virus (de Groot, Baker, Baric, Brown, Drosten, Enjuanes, Fouchier, Galiano, Gorbalenya, Memish, Perlman, Poon, Snijder, Stephens, Woo, Zaki, Zambon, & Ziebuhr, 2013). The second outbreak of coronavirus happened in late December 2019, in Wuhan, China; In Hubei province was from an infection due to new coronavirus-19 (2019-nCoV) and the disease was designated as COVID-19. In COVID-19, patients develop respiratory illness mostly presented as cough, dyspnoea and fever (Zhu *et al.*, 2019). It was found fever may not be present in very young or old people, immune-compromised and those taking certain medications. The largest outbreak of MERS-CoV was reported in Korea in 2015 in a person who had a travel history to the Arabian Peninsula (Harrath, & Abu Duhier, 2018). MERS-CoV was reported first in Jordan in 2012, and then in Saudi Arabia in

September 2012. After further research it was found the source of the infection was MERS-CoV (Brebant, Riou, & Fontanet, 2013), it was postulated that it is likely to have an animal source and later found to be present in the camels in these Arabian countries: Lebanon, Saudi Arabia, UAE, Qatar, Oman, Jordan, Kuwait, Iran, Bahrain, Iraq, Israel, and Gaza, Syria, and Yemen (Guery, Poissy, Mansouf, Séjourné, Ettahar, Lemaire, Vuotto, Goffard, Behillil, Enouf, Caro, Mailles, Che, Manuguerra, Mathieu, Fontanet & Werf, 2013). Camel is a national animal of Arab countries and many tribes keep camels as possession. One of the risk factors for MERS-CoV was the direct contact of human beings with camels (Sikkema, Farag, Himatt, Ibrahim, Al-Romaihi, Al-Marri, Thani, El-Sayed, Al-Hajri, Haagmans, Koopmans, & Reusken, 2017). Hence, the authorities warned people to take precautions when visiting barns, farms, or any other place where these animals were kept (Zumla, Drosten, & Azhar, 2019). In addition, people were also advised to practice hygiene measures like regular hand washing if exposed to camels who may have been infected with the viral disease. It was studied that training and milking of camels were associated with MERS-CoV infections (Zumla *et al.*, 2019). Those people who had co-morbidities like weak immune system, chronic diseases, diabetes mellitus, lung diseases, and/or kidney diseases were at greater risk of getting infected with MERS-CoV; additional precautions were given such as: prohibiting consumption of camel meat, milk and raw urine which few people use for its medicinal value.. A seasonal pattern of cases was also observed with the high rate of infection being seen in the month of May. (Chan, Hemida, Kayali, Chu, Poon, Alnaeem, Ali, Tao, Ng, Chan, Guan, Nicholls, & Peiris, 2014). An explanation for this seasonal time infection rate being high could be camel birthing season when young camels are more prone to infection (Chan *et al.*, 2014). It was found in these markets indigenous camels were mixed with imported camels from Somalia, Sudan and other countries. COVID



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## فيروس كورونا المسبب لمتلازمة الشرق الأوسط التنفسية من الاكتشاف إلى التدخل في منطقة الشرق الأوسط: دراسة مرجعية

### حياة علي الزهراني<sup>1</sup> & أنشو أغاروال<sup>2</sup>

(قدم للنشر في 1442/7/1 هـ ؛ وقبل للنشر في 1442/11/12 هـ)

**ملخص البحث:** يسبب فيروس كورونا المسبب لمتلازمة الشرق الأوسط التنفسية (MERS-CoV) الذي ينتمي إلى عائلة الفيروس التاجي متلازمة الشرق الأوسط التنفسية (MERS). المرضى، الذين أصيبوا بفيروس كورونا المسبب لمتلازمة الشرق الأوسط التنفسية، ومعظمهم حدث لهم تطور إلى مرض خطير في الجهاز التنفسي. وقد حدثت العديد من الأوبئة الفيروسية في مناطق بيولوجية مختلفة في العقدين الماضيين. يعود سبب COVID-19 الذي بدأ في النصف الثاني من ديسمبر 2019 كتفشي جديد للجائحة إلى سلالة جديدة من الفيروس التاجي، حيث أن تصنيف الجينات لا يمكن أن يتطابق مع سلالات الفيروس التاجي السابقة. لذلك تم تصنيف هذه السلالة الجديدة على أنها 2019-nCoV أو Cov 2 وتصنف تحت متلازمة الالتهاب التنفسي الحاد. هذه السلالة الجديدة لديها معدل عال جدا من الانتشار من خلال الرزاز المتطاير من الفم وهو قابل للانتقال. العدوى الخطيرة والشديدة التي تتطلب دخول وحدة العناية المركزة والتهوية هي 5%، ويعتبر المرضى الذين يحتاجون إلى الأكسجين والذين لديهم عدوى خطيرة وهم 15% من مجموع المرضى الذين يصابون بهذا الفيروس وبقية المرضى ليس لديهم أي أعراض أو أعراض خفيفة جدا والتي تشكل حوالي 80% من العدوى. هذه الدراسة تسلط الضوء على رحلة هذا الفيروس من منشأه منذ سنوات عديدة في الشرق الأوسط على الرغم من أنه كان معروفا بأسماء فريدة ويبدو الآن أنه يظهر سلالة جديدة بسبب جينوم غير عادي تحت اسم (كوفيد - 19) COVID-19.

**الكلمات المفتاحية:** جائحة، الشرق الأوسط، عاصفة السيوتوكين، متلازمة الشرق الأوسط التنفسية، متلازمة الالتهاب التنفسي الحاد، كوفيد-19 .

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## Middle East Respiratory Syndrome Coronavirus from Discovery to Intervention in the Middle East Region: A Review

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**Abstract:** Middle East Respiratory Syndrome Coronavirus (MERS-CoV) which belongs to the family of coronavirus causes Middle East Respiratory Syndrome (MERS). Most of the patients, who got infected with MERS, develop a serious respiratory illness. Numerous viral epidemics have surfaced in different biological regions in the last two decades. COVID-19 which began in the second half of December 2019 as a novel pandemic outbreak, is due to a new strain of coronavirus, as categorization of genes could not match the earlier coronavirus strains. This new strain had been labeled as 2019-nCoV or Cov 2 and is classified under severe acute respiratory distress syndrome. This new strain has a very high rate of spread through the droplet infection and it is transmissible. The serious and dangerous infections which require ICU admission and ventilation. Five percent (5%) of patients who require oxygen are considered to have a serious infection and makeup fifteen percent (15%) of total patients infected. Whereas, eighty percent (80%) of the infected patients have no or mild symptoms. This study explores the journey of this virus from its origin many years ago in the Middle East; though it was known with unique names and now seems to be emerging as a new strain due to an unusual genome under the name of COVID -19.

**Keywords:** Pandemic, Middle East, Cytokine storm, MERS, SARS, Covid-19

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**Appendix I**  
***Cronbach Alpha Coefficients***

Job Satisfaction Survey	Description	Value
Scale		
Pay	Pay and remuneration	0.71
Promotion	Promotion opportunities	0.67
Supervision	Immediate supervisor	0.75
Fringe Benefits	Monetary and nonmonetary fringe benefits	0.89
Contingent Rewards	Appreciation, recognition, and rewards for good work	0.73
Operating Procedures	Operating policies and procedures	0.69
Co-workers	People you work with	0.81
Nature of Work	Job tasks themselves	0.77
Communication	Communication within the organization	0.76
Total		0.93
Expanded Nursing Stress	Description	Values
Scale		
Death	Death and Dying	0.81
Conflict	Conflict with Physicians	0.79
Emotional Preparation	Inadequate Emotional Preparation	0.75
Problems	Problems related to peers	0.83
Work load	Job workload	0.64
Uncertainty	Uncertainty concerning treatment	0.72
Families	Patients and their families	0.61
Discrimination	Discrimination in the workplace	0.78
Maslach Burnout Inventory (MBI)	Description	Values
Emotional Fatigue		0.90
Depersonalization		0.81
Personal Accomplishment		0.89
Total		0.94

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behavior and satisfaction towards the job are affected by stress. These findings are corroborated by Warshawsky (2018) and Deng, Guo, Ma, Yang & Tian (2019). However, Portero de la Cruz & Vaquero Abellán (2015) contradict these results by reporting moderate level of stress among nurses as compared to present research reporting low stress levels. The deviation in the two study findings might be due to the cultural variation, healthcare nature, patient's attitude as well as work treatment and condition.

## 5. CONCLUSION

This study has examined the impact of burnout and professional outbreaks and other factors on job satisfaction of Saudi nurses. The primary motive was to investigate the sources and factors that lead to job satisfaction and ultimately impact the overall work environment. The findings depict nurses are dissatisfied with the benefits offered to them, which are essential to overcome and sustain effective work performance. Likewise, the study concluded stress and job satisfaction are substantially correlated. Overall, nurses were satisfied with their jobs at KSMC. High job satisfaction will lead to the development of a healthy work environment, where nurses would feel inclined to provide the best care for achieving the best health outcomes.

## 6. LIMITATIONS

Although the study makes a valuable contribution, it has few limitations such as the inclusion of nurses from only one region, and items of the questions limited to two scales. Similarly, the research design and use of quantitative approach limits the generalizability of the obtained results.

## 7. RECOMMENDATIONS

Future studies are recommended to overcome these limitations and undergo further research in their respective areas. Therefore, a more in-depth blueprint of nurse burnout and stress needs to be developed.

Moreover, empirical studies should be carried out to examine these complicated associations, prospectively. Intervention studies can be conducted to evaluate the most useful ways for mitigating work stress, once it is investigated from a more comprehensive theoretical and conceptual foundation.

Overall, the findings of this study proffer preventive and coping strategies must be instigated for managing nurse burnout and satisfaction level. Therefore, it is recommended that a coping mechanism particular to nursing should be adopted to reduce stress on their job and ignore the emotional objectives in nursing regarding the performance of their work. Nurse administrators can be more satisfied by mitigating the stressful nature of nurses' work to improve those managerial behaviors that enhance the work environment for staff nurses. Lastly, enhanced working conditions might make the role more interactive and assist in correcting the crucial lack of individuals interested to pursue administrative positions.

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#### 4. DISCUSSION

The aim of the study was to assess the relationship between professional outbreaks, stress burnout, and job satisfaction among nurses at KSMC, Saudi Arabia. The study has mainly focused on investigating the sources and factors impeding the performance of the nurses and impacting the overall work environment. The study highlighted corrective measures that might improve the work dynamics and retention of Saudi nurses. These results corroborate one of the previous studies stating effective work environment and collaborative work practice improve work productivity among the nurses (Das, Biswas, Reza, Akhtar, Kawsar & Hossain, 2018). The demographics of the study showed non-Saudi population to be the majority, this could be the reason there was a low level of stress seen in the population. However, according to Al-Ahmadi (2002), there was no difference in job satisfaction among Saudi nurses based on ethnicity. Also, a majority of the nurses reported to work on rotation shifts and not solely on night shifts, as night shift is a factor that can impact work life balance of nurses. Similarly, Prasanty, Husada, Effendy & Simbolon (2018) demonstrated low and medium level of stress may be attributed to different work characteristics and condition of the nurses.

The relationship between stress and satisfaction among nurses is a significant phenomenon affecting patient safety in general. The study found positive relationship between pay, promotion and benefits on the job satisfaction. The health, job dissatisfaction, well-being, turnover, and the rate of absenteeism of nurses is significantly affected by stressors (Saleh, Saleh & AbuRuz, 2013). However, the present study has reported low level of stress and generally nurses were satisfied with their job at KSMC, which could be due to adequate salary and less discrimination. As majority of the nurses here were of ethnic minority, which could be another reason there was less discrimination and more job satisfaction.

Nursing is already recognized as a stressful job; however, nurses in the present study are highly satisfied with their job maybe because they feel less stressful working in a hospital setting. The results of

the study are similar to a study conducted in Australia, where hemodialysis nurses had acceptable levels of job satisfaction (Hayes, Bonner, & Douglas, 2013). On the contrary, another study reported low levels of job satisfaction and experienced moderate to high levels of burnout (Alharbi, Wilson, Woods & Usher, 2016). Atefi, Abdullah, & Wong (2016) showed association between high level of job satisfaction among nurses with a high level of staff retention and decrease absenteeism from work. Furthermore, both job satisfaction and quality of life are closely linked. This study reported workload to be highly linked with job satisfaction. It is important to have manageable workload assigned to nurses as job satisfaction among nurses is an indication of the quality of service rendered for patient care and a good indicator of the quality of life of nurses (Iyer, 2017).

The current findings revealed nurses are dissatisfied with the benefits offered to them, which is in agreement with the findings of Batayneh, Ali & Nashwan (2019). Likewise, Kaddourah, Khalidi, Abu-Shaheen & Al-Tannir (2013) and Karkar, Dammang & Bouhaha (2015) showed that promotion and benefits were highly correlated with job satisfaction of nurses. These results are also in agreement with other research showing that accomplishment sense impacts the nurse's job satisfaction (Kaddourah et al., 2013; Khamisa, Oldenburg, Peltzer & Ilic, 2015).

The findings of this study depicted positive and significant effect of emotional exhaustion, depersonalization, and personal accomplishment with job satisfaction of Saudi nurses. On the contrary, Oliveira et al. (2018) showed a weak association between job satisfaction and depression; although, there was no significant relationship between emotional exhaustion, depersonalization, and job satisfaction. The current findings also showed overall satisfaction level was significant and positively correlated with stress concerning the nurse's promotion. These results were in agreement with the study of Montgomery, Spânu, Băban & Panagopoulou (2015), as it reported that promotion at job impacts the nurse's ability to cater to patients' needs. Similarly, Williams, Costley, Bellury & Moobed (2018) showed



Path analysis showed a significant and positive impact of payment (p-value=0.04), promotion (p-value=0.00), fringe benefits (p-value=0.01), contingent rewards (p-value=0.01), operating

procedure (p-value=0.00), co-workers (p-value=0.00), nature of work (p-value=0.00), and communication on job satisfaction (p-value=0.02) of nurses (Table 3).

**Table 3: Path Analysis of Job Satisfaction Survey**

	<b>Estimate</b>	<b>S.D.</b>	<b>T-Stats</b>	<b>Prob.</b>
<b>Pay → Job Satisfaction</b>	0.13	0.07	1.82	0.04
<b>Promotion→ Job Satisfaction</b>	0.35	0.05	6.74	0.00
<b>Supervision→ Job Satisfaction</b>	-0.20	0.07	2.80	0.00
<b>Fringe Benefits → Job Satisfaction</b>	0.15	0.06	2.38	0.01
<b>Contingent Rewards→ Job Satisfaction</b>	0.19	0.07	2.56	0.01
<b>Operating Procedure→ Job Satisfaction</b>	0.87	0.02	37.16	0.00
<b>Co-workers→ Job Satisfaction</b>	0.41	0.08	5.08	0.00
<b>Nature of Work→ Job Satisfaction</b>	0.87	0.02	44.53	0.00
<b>Communication→ Job Satisfaction</b>	0.18	0.09	1.97	0.02
<b>Emotional Fatigue→ Job Satisfaction</b>	0.45	0.06	2.05	0.00
<b>Depersonalization→ Job Satisfaction</b>	0.81	0.01	24.25	0.00
<b>Personal Accomplishment→ Job Satisfaction</b>	0.17	0.05	2.17	0.02

Table 4 also shows significant and direct impact of conflicts (p-value=0.01), emotional preparation (p-value=0.01), problems (p-val-

ue=0.02), uncertainty (p-value=0.04), and discrimination (p-value=0.00) on job satisfaction of nurses.

**Table 4: Path Analysis of Expanded Nursing Stress Scale**

	<b>Estimate</b>	<b>S.D.</b>	<b>T-Stats</b>	<b>Prob.</b>
<b>Death → Job Satisfaction</b>	0.31	0.09	1.28	0.74
<b>Conflict→ Job Satisfaction</b>	0.53	0.06	3.64	0.01
<b>Emotional Preparation→ Job Satisfaction</b>	-0.02	0.08	1.51	0.01
<b>Problems→ Job Satisfaction</b>	0.51	0.03	1.83	0.02
<b>Work Load→ Job Satisfaction</b>	0.91	0.04	1.65	0.03
<b>Uncertainty→ Job Satisfaction</b>	0.78	0.01	23.61	0.04
<b>Families→ Job Satisfaction</b>	0.14	0.05	3.80	0.81
<b>Discrimination→ Job Satisfaction</b>	0.78	0.03	34.35	0.00

Work characteristics of nurses showed that employment duration for a majority of nurses was more than four years (52.65%); while, 40.4% of the nurses were employed for 5 to 10 years (Table 2). A department-wide distribution of participants demonstrated an even pattern where the lowest percent-

age was found at the burn unit (7.4%). Similarly, the work shift showed that a majority of the nurses (82.2%) worked on rotations; while, 17.8% worked on day shift only. The salary range of the nurses showed majority (65.7%) were compensated in the range of SAR 5,000 to 10,000.

**Table 2: Work Characteristics of Nurses**

Variable		Frequency (n)	Percentage (%)
<b>Duration in Unit</b>			
	Less than one year	41	13.8
	1 to 4 years	100	33.7
	More than 4 years	156	52.5
<b>Duration in Nursing</b>			
	Less than 5 years	58	19.5
	5 to 10 years	120	40.4
	Above 10 years	119	40.1
<b>Department</b>			
	Medical	38	12.8
	Surgery	56	18.9
	Cardio	47	15.8
	Paediatrics	36	12.1
	Burn Unit	22	7.4
	Emergency	48	16.2
	Obstetrics	50	16.8
<b>Shift</b>			
	Day	53	17.8
	Night	244	82.2
<b>Nature</b>			
	Day	53	17.8
	Night	0	0
	Rotation	244	82.2
<b>Salary (SAR)</b>			
	Less than 5000	89	30.0
	5000 to 10000	195	65.7
	Above 10000	13	4.4

### 2.5.4. Maslach Burnout Inventory (MBI)

The Maslach Burnout Inventory (MBI) was used to measure the degree of professional burnout comprised of 22 items (Maslach, Jackson & Leiter, 1996; Maslach & Leiter, 2016). The participants' responses were based on how rapidly they experience the feelings ranging from never to few times per year or less, once per month or less, few times per month, once per week, few times per week, and every day. The literature has not provided any valid cut-off points for measuring the presence of professional burnout and to differentiate the cases. Three dimensions of professional burnout have been determined including emotional fatigue (9 items), de-personalization (5 items), and personal accomplishment (8 items).

### 2.6. Pilot Testing

The questionnaire was sent to two professionals in the sociology department of the University question validation. The purpose of validating the questionnaire was to determine the clarity level of items before collecting the data. Several recommendations were presented by both professionals in modifying the questionnaire. A pilot test was carried out after making corrections in the questionnaire from a sample of 30 nurse (10% of total sample). These nurses were not included in the final sample size. Cronbach Alpha coefficient was used to measure the reliability of

the instrument, setting a benchmark of 0.60. The Cronbach values of both the questionnaires are presented in Appendix I.

### 2.7. Data Analysis

The researcher analyzed the data using IBM Statistical Package Social Science Software (SPSS) version 20, once the questionnaire completeness was verified. Descriptive statistics were presented in the form of frequencies and percentages for demographic variables and the work characteristics of nurses.

## 3. FINDINGS

The demographic profile showed that most of the nurses were female (267); and 30 were male. 30 male nurses (Table 1). Details pertaining to respondents' nationality were also collected, which showed most of the nurses were non-Saudi (89.6%) (Table 1). Concerning the age, it was found most of the nurses were in the age bracket from 20 to 30 years (53.5%), followed by nurses aged between 31 to 40 years (37%), and lastly by nurses aged between 40 to 50 years (9.1%). Analysis of the marital status of the sample showed that most of the nurses were married (59.6%); while, 40.4% were single. Most of the nurses had completed their graduation (75.4%), followed by a diploma (23.6%), and masters (1%).

**Table 1: Demographics**

Item	Measure	Frequency	Percentage
Gender	Male	30	10
	Female	267	90
Nationality	Saudi	31	10.4
	Non-Saudi	266	89.6
Age	20-30 years	159	53.5
	31-40 years	110	37
	41-50 years	27	9.1
	Above 40 years	1	0.3
Marital Status	Single	120	40.4
	Married	177	59.6

## 2. METHODS

### 2.1. Study Design

A descriptive cross-sectional correlational research design is used to examine the relationship between professional outbreaks, burnout, and job satisfaction. The rationale for the use of this research design is twofold; it helps in the statistical representation of the findings which are easy to comprehend based on an unbiased data (Abu Yahya, Ismaile, Allari & Hammoudi, 2019). Secondly, this same design was adopted by previous researches of similar discipline that establish the efficiency of this design (Oliveira et al., 2018; Abu Yahya et al., 2019). Also, the present study differs from earlier studies based on its region, unit, population and sample size.

### 2.2. Study Setting

The research was held in critical care departments in King Saud Medical City–Riyadh–KSA (KSMC). KSMC is a public tertiary care center for medicine and surgery. A total of 300 questionnaires were distributed at random to critical care nurses in seven care departments including: intensive care unit, emergency department, surgical, medical, neuroscience, pediatric, and the dialysis ward. The study was conducted from January to July of 2020.

### 2.3. Study Sample

The nurses were recruited using convenient sampling method as it assists in generalizing the results across different sectors and the overall hospital body. Initially, 300 participants were considered for data collection; however, the final sample comprised of 297 participants. The researcher also communicated the study details to the selected participants prior to their participation. The participants were assured of anonymity and confidentiality. The researcher communicated the data would only be used for research purposes and participants could withdraw at any point during the study.

### 2.4. Ethical Consideration

The study was approved by Institutional Review Board/Local Ethical Committee (IRB) of King Saud University (KSU). After obtaining the approval and

ascertaining the questionnaire reliability, the researcher contacted the Director of the Research Center in King Saud Medical City to share the study details in written form. A meeting was arranged with the Executive Director of Nursing, where the data collection procedure was determined.

### 2.5. Study Tool

A questionnaire that was conducted, consisting of four parts; demographic details, Job Satisfaction Survey (JSS), Expanded Nursing Stress Scale (ENSS), and Maslach Burnout Inventory (MBI).

#### 2.5.1. Demographics

The demographic of (part 1) collected information about the participant's age, gender, nationality, marital status, qualification, working experience in the present unit, and work departments.

#### 2.5.2. Job Satisfaction Survey (JSS)

The second section used JSS for assessing the degree of satisfaction of the nurses with their job. It was based on nine sub-scales; pay, supervision, promotion, fringe benefits, contingent rewards, and co-workers, operating conditions, work nature, and communication. The responses of the participants were categorized into six items (i.e., 1 for much disagreement, 2 for disagreeing moderately, 3 for disagreeing slightly, 4 for agreeing slightly, 5 for agreeing moderately, and 6 for agreeing very much). The scale's reliability and validity were established based on Cronbach's alpha value (Spector, 1985).

#### 2.5.3. Expanded Nursing Stress Scale (ENSS)

The third section studied stress level of the participants using the ENSS scale. Originally developed by Gray-Toft & Anderson (1981), comprising of 57 items based on 5 points Likert. The scale range comprised 1 for 'never stressful,' 2 for 'occasionally stressful,' 3 for 'frequently stressful,' 4 for 'extremely stressful,' and 0 for 'do not apply'. These were based on seven subscales; namely, Death and Dying, Conflict with Physicians, Inadequate Emotional Preparation, Problems Relating to Peers, Problems Relating to Supervisors, Work Load, Uncertainty Concerning Treatment, Patients and their Families, and Discrimination.

## 1. INTRODUCTION

Nurses substantially contribute to the overall health infrastructure of a country (Abdullah & Nusari, 2019). They are constantly exposed to emotional load of patients, combined with increased work demand and responsibilities (Oliveira, Silva, Galvão & Lopes, 2018). In the long run, the nurses' exposure to these conditions cause adverse impact on their psychological well-being and work performance (Van Mol, Kompanje, Benoit, Bakker & Nijkamp, 2015; Oliveira et al., 2018). These condition might promote the use of medicines, alcohols, and other means to alleviate the occurring symptoms. Healthcare organizations are instigating various efforts to highlight the significance of professional outbreaks that can serve as an effective intervention (Cañadas-de la Fuente, San Luis, Lozano, Vargas, García, & Emilia, 2014; The, 2017).

Nurses are engaged in various departmental units of the hospital administration as clinical staff and the nature of their work make them highly susceptible to burnout conditions (Yarbrough, Martin, Alfred, & McNeill, 2017). Non-compliance and heavy workload are important risk factors for burnout among nurses in the healthcare organizations (Asiamah, Mensah & Azinga, 2019). Job dissatisfaction is the most dominant factor of burnout and it refers to the degree in which employees like their jobs and have a negative or positive attitude toward their jobs. Nurses with negative feelings usually experience dissatisfaction (Gordon, 2017). Nurses experiencing burnout and job dissatisfaction can represent these situations in quality of care and patient care (Kadir, Kamariah & Saleh, 2017).

Professional outbreak is recognized as a cost expanding factor for the organization (Chuang, Tseng, Lin, Lin & Chen, 2016). It is reflected in three aspects; emotional exhaustion, depersonalization, and lowered fulfillment as a healthcare professional (Maslach & Leiter, 2016). Azad and Gholami (2010) revealed professional outbreak and burnout accounts for a loss of four billion pounds in the expansion of hospital faculty. Gregory (2015) showed the major determinants of nurse burnout are value confluence, workload and control. Ford (2019) ar-

gued frontline care is one of the dilemmas leading to burnout among nurses and several healthcare experiences are fraught with human suffering.

Professional outbreaks have been explored among nurses and observed that professional outbreaks among nurses result in patient dissatisfaction, increased mortality, and failure to rescue (Sarafis, Rousaki, Tsounis, Malliarou, Lahana, Bamidis & Papastavrou, 2016; Duarte, Pinto-Gouveia & Cruz, 2016). A relationship between nursing management and development process of stress confirms that administrative and management responsibilities are another major source of stress among nurses (Moreland & Apker, 2016). Lack of resources, disagreement role among nurses, workload, conflict, and role ambiguity are the consequences of poor management (Jaracz, Rosiak, Bertrand-Bucińska, Jaskulski, Nieżurawska & Borkowska, 2017). Therefore, lack of adequate stress management at hospitals is a major source of stress in different units.

There is a need to examine professional outbreak, stress burnout, and satisfaction across different units including intensive care unit, emergency department, pediatric, medical, surgical, neuroscience, and the dialysis ward to expand the study arena. Thereby, this study aims to assess the relationship between nurses' burnout and job satisfaction. The study is driven due to the shortage of Saudi nurses as compared to others, which represent 25% of the total nurse workforce (Almajwal, 2016) and expansion in public and private hospitals (Ambani, 2017). The study findings are likely to contribute towards the development of a competent healthcare workforce; while, simultaneously improve the retention and performance statistics of the industry. Moreover, this study can be a benchmark in the Saudi context to present evidence related to the relationship between professional outbreaks, burnout, and job satisfaction. The hypotheses tested in the present study are as follows;

H1: There is a direct relationship between burnout, professional outbreaks, and job satisfaction among nurses.

H2: Job satisfaction among nurses is directly affected by professional outbreaks and burnout.



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## تقييم العلاقة بين الانهك والانهيار المهني، الاجهاد، والرضا الوظيفي بين المرضى: دراسة مقطعية

بندر ظافر الشهري<sup>1</sup> & عمر غازي بكر<sup>2</sup>

(قدم للنشر في 1441/11/5 هـ؛ وقبل للنشر في 144/9/28 هـ)

**ملخص:** تم اكتشاف حالات الانهك والانهيار المهني، والاجهاد، ومشكلات مرضية بين المرضى مما أدى إلى استياء المرضى، وبطء الشفاء و سرعة الاستجابة. تهدف هذه الدراسة إلى تقييم الانهك والانهيار المهني، والإجهاد، والرضا الوظيفي بين المرضى في المملكة العربية السعودية. اشتمل التصميم الوصفي المقطعي على 297 ممرض من خلال طريقة اختيار العينات الملائمة في مدينة الملك سعود الطبية. تم استخدام طريقة المسح القائم على الاستبيان، والمكون من اربعة اجزاء: (1) المعلومات الديموغرافية، (2) استبانة الرضا الوظيفي (3)، (JSS) مقياس الاجهاد التمريضي الموسع (4)، (ENSS) و مقياس ماسلاخ للاجهاد (MBI) أظهرت النتائج تأثيراً هاماً وإيجابياً للمرتب النقدي (القيمة الاحتمالية = 0.04) والترقيه (القيمة الاحتمالية = 0.00) والمزايا الإضافية (القيمة الاحتمالية = 0.01) والمكافآت غير المتوقعه (القيمة الاحتمالية = 0.01) وإجراءات التشغيل، (p-value = 0.00) وزملاء العمل، (p-value = 0.00) وطبيعة العمل (p-value = 0.00)، والتواصل مع الرضا الوظيفي (p-value = 0.02) للمرضين. علاوة على ذلك، يتأثر الرضا الوظيفي بشكل مباشر بالصراعات داخل العمل (p-value = 0.01)، والجاهزية العاطفيه (p-value = 0.01)، والمشكلات (p-value = 0.02)، وعدم اليقين (p-value = 0.04)، والتميز (p-value = 0.00). وبناءاً على ذلك يجب أن يتم تعزيز فرص الترقية والتطوير الوظيفي بوضوح وأن يتم تحفيز أنشطة الوقاية للحد من التوتر. علاوة على ذلك، يجب تنفيذ السياسات للتعامل مع الانهك والانهيار المهني والاجهاد للمساعدة في تحسين الاحتفاظ بالمرضى والتغلب على الغياب والتسرب بينهم.

الكلمات الرئيسية: الإجهاد، الرضا الوظيفي، المرضى، الانهك والانهيار المهني.

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## Assessing the Relationship Between Professional Outbreaks, Burnout, and Job Satisfaction among Nurses: A Cross-Sectional Study

Bandar Dhafer Alshehri<sup>1</sup> & Omar Ghazi Baker<sup>2</sup>

(Received 26/6/2020; Accepted 10/5/2021)

**Abstract:** Professional outbreaks, burnout, and issues with satisfaction have been explored among nurses that result in patient dissatisfaction, increased mortality, and failure to rescue. This study aims to evaluate the professional outbreak, stress burnout, and satisfaction among nurses in the region of Saudi Arabia. A descriptive cross-sectional design was followed by recruiting 297 nurses through the convenient sampling method of King Saud Medical City (KSMC). A questionnaire, comprising of four parts; Demographic Details, Job Satisfaction Survey (JSS), Expanded Nursing Stress Scale (ENSS), and Maslach Burnout Inventory (MBI) was used to collect data. The findings have shown a significant and positive impact of payment (p-value=0.04), promotion (p-value=0.00), fringe benefits (p-value=0.01), contingent rewards (p-value=0.01), operating procedure (p-value=0.00), co-workers (p-value=0.00), nature of work (p-value=0.00), and communication on job satisfaction (p-value=0.02) of nurses. Moreover, job satisfaction is directly affected by conflicts (p-value=0.01), emotional preparation (p-value=0.01), problems (p-value=0.02), uncertainty (p-value=0.04), and discrimination (p-value=0.00). Promotion and career development opportunities must be clearly communicated and prevention activities should be instigated to reduce stress. Moreover, policies should be implemented to deal with the professional burnout to help improve the retention by overcome absenteeism and turnover.

**Keywords:** Burnout, Job Satisfaction, Nurses, Professional Outbreak.

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activated protein kinase), which play a major role for NF $\kappa$ B induction and TNF-alpha formation (Yin, Sandhu, Wolfgang, Burrier, Webb, Rigel, Hai, & Whelan, 1997). TNF-alpha increment has been involved in many inflammatory diseases of renal tissue, such as diabetic nephropathy, acute renal failure, glomerulonephritis, and autoimmune lupus nephritis (Bertani, Abbate, Zoja, Corna, Perico, Ghezzi, & Remuzzi, 1989; Azuma, Nadeau, Takada, Mackenzie, & Tilney, 1997; Boswell, Yui, Burt, & Kelley, 1998), resulting in pro-inflammatory mediator formation (Donnahoo, Meng, Ao, Ayala, Shames, Cain, Harken, & Meldrum 2001). TNF-alpha stimulates cellular dysfunction and apoptosis in renal tissue and inhibits glomerular filtration rate, glomerular permeability and glomerular blood flow via inducing the vasoactive mediators formation (i.e. endothelin-1, nitric oxide, platelet-activating factor, eprostaglandins, IL-1) as reported by (Kohan, 1994; Baud & Ardaillou, 1995; Gomez-Chiarri, Ortiz, Lerma, Lopez-Armada, Mampaso, Gonzalez, & Egido, 1994; Soler, Mullin, Knudsen, & Marano, 1996). Thus, it could be concluded that TNF-alpha possess the autocrine and the paracrine, that attributed to the kidney damage (Radeke, Meier, Topley, Floge, Habermeh, & Resch, 1990; Mullin, Laughlin, Marano, Russo, & Soler, 1992). COX-2 is an enzyme responsible for inflammation and pain. The up-regulation in COX-2 expression was showed in the epithelial cells of the renal tubules as a result of E102 administration. These data were in agreement to Khayyat, Essawy, Sorour, & Soffar (2018) who delineated that the administration of Allura red and sunset yellow food dyes caused increase of COX2 expression.

The mechanism of Fas augmentation is very complicated, as IL-1 $\alpha$ , and tumor necrosis factor (TNF) induced Fas expression in cultured renal tubular cells. Because apoptosis and Fas up-regulation along with the renal tubular atrophy. It was concluded that tubular cells are targeted for Fas-dependent apoptotic deletion, which attributed to tubular atrophy. The author indicated many pro-inflammatory markers such as IL-1 and TNF, stimulated indirectly tubular atrophy via Fas-dependent renal tubular cells apoptosis (Schelling & Cleveland, 1999). Increase in apoptosis in remnant renal tissue was likely to be Caspase-3-dependent as it is associated with increases in Caspase-3 levels causing renal cell apoptosis and fibrosis (Yang,

El Nahas, Thomas, Haylor, Watson, Wagner, & Johnson, 2001). The decrease in Bcl-2 expression in the present study agreed with the result of Khayyat *et al.* (2018) who showed that there is a down-regulation of Bcl-2 as a result of the administration of sunset yellow and Allura red food dyes. E102 administration caused increase in the mRNA levels and immuno-histochemical localization of the renal caspase-3, collagen 1- $\alpha$ , TGF $\beta$ -1, and fibronectin (fibrotic markers) in rats (Abd-Elhakim, et al., 2019).

Vit E injection counteracted E102 side effect on apoptotic and anti-apoptotic markers production for TNF-alpha, Cox-2, caspase-3, CD95, and Bcl-2. These results suggested the protective effect of vit E in preventing renal damages via modulation of such cytokines.

## 5. CONCLUSION

This could be considered the first study concerned with the therapeutic effect of vit E on immunological status of renal tissue; against deleterious effects of E102. Vit E proved its modulatory effect in ameliorating the altered immunological parameters tested in this study. The application of such treatment in clinical field will improve human health and decrease the treatment cost of diseases.

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#### 4. Discussion

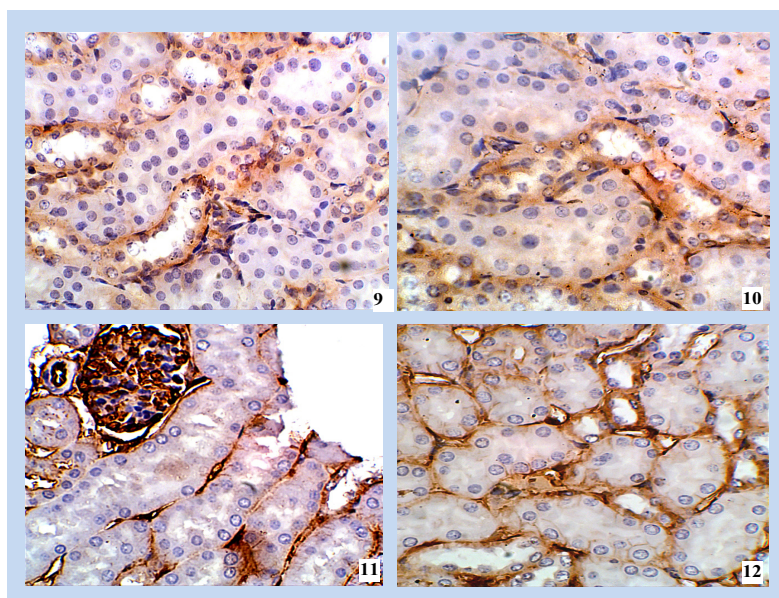
The kidney is the filtering organ of the plasma and is constitutively reabsorbing selected items of the glomerular filtrate, which is an energy consuming process. Kidney damage is attributed to the fact the glomeruli is the primary site of action of several chemicals and it may be injured by any toxic, metabolic and immunologic mechanisms. The toxic irritant substances brought to the kidney by circulatory blood cause degenerative changes in the kidney tissues. This study revealed changes in the kidney function, antioxidant status and immunological parameters as a result of E102 administration which lead to remarkable histopathological effects in the kidney. Many studies conducted by Khayyat, Essawy, Sorour, & Soffar, (2017) showed a significant increase in plasma uric acid, urea and creatinine levels in E102-treated animals (Abd-Elhakim, Moustafa, Hashem, Ali, Abo-EL-Sooud, & El-Metwally, 2019). Organic azo dye fast green and E102 administration caused an increment in serum creatinine level (Ashour & Abdelaziz, 2009; Himri, Bellahcen, Souna, Belmekki, Aziz, Bnouham, Zoheir, Berkia, Mekhfi, & Saalaoui, 2011). Deterioration of kidney function was attributed to the increase levels of creatinine and urea, reduction of zinc and iron content in renal tissue (Cemek, Büyükokuroğlu, Sertkaya, Alpdağtaş, Hazini, Önül, & Göneş, 2014). E102 administration caused significant increase in serum urea and creatinine observed in rats. Hence, it is compulsory to minimize usage of food coloring dyes in processed food produced for children (El-Wahab & Moram, 2013). The increase in kidney function parameters leading to the impairment of renal tissue ability to filtrate body fluids which authenticated with the histopathological and antioxidant status of renal tissue in this study.

In the present study a significant decrease in GSH, GST, SOD, CAT and augmentation in MDA activities was found as a result of E102 administration which in agreement with studies of El-Wahab & Moram, (2013); and El-Desoky, Abdel-Ghaffar, Al-Othman, Habila, Al-Sheikh, Ghneim, Giesy, & Aboul-Soud, (2017). Following the same line; Amin, Abdel Hameid, & Abd Elsttar (2010) and Abd-Elhakim, et al. (2019) reported an augmentation in the MDA and inhibition in SOD, CAT, and GSH levels in the kidney due to the treatment of E102

to rats (Mohamed, Galal, & Elewa, 2015; Saxena & Sharma, 2015). E102 considered a toxic agent as a result of its oxidative impairment induced by inhibition of GSH and increase of MDA; GSH is known as the major cellular antioxidant. Therefore, the usage of food dyes obligated to be re-estimated (Demirkol et al., 2012).

E102 administration caused many deleterious effects to renal tissue authenticated with the increase levels in renal parameters. The histopathological investigation consolidated the biochemical analysis of the present study, revealing interstitial and glomerular congestion, edema, and mild vacuolar degeneration of renal proximal convoluted tubules which are similar to what was reported by Balta Sevastre, Mireşan, Taulescu, Raducu, Longodor, Marchiş, Mariş, & Coroian (2019); shrunken glomeruli, periportal fibrosis with tubular necrosis, loss of renal tubules integrity and fibrous tissue proliferation are also reported by Abd-Elhakim, et al. (2019). Khayyat, et al., (2017) reported renal proximal and distal tubular degeneration. Tubular cells appeared with pyknotic nuclei and vacuolated cytoplasm and contain increased number of lysosomes and disrupted mitochondria.

The present investigation showed an increase in CD95, caspase-3, COX-2, TNF-alpha and a decrease in Bcl-2 expression in serum and renal tissue. This elevation in CD95 and caspase-3 and the inhibition in Bcl-2 is an obvious evident for renal inflammation that occurred in the damaged tubular cells. The mechanism of TNF-alpha-induced renal injury is multiple, where its increase leads to renal dysfunction. The damaged renal tubules observed in this study was considered as a sources of the increased expression of TNF-alpha. Also, the inflamed kidney infiltrating leukocytes, podocytes, mesangial cells, proximal tubules, ascending limbs and collecting ducts are major sources of TNF formation as conducted by Zager, Johnson, Hanson, & Lund, (2005); Rosa, Rattazzi, Miglio, Collino, & Fantozzi, (2012). The administration of E122 (synthetic food dye) caused the formation of reactive oxygen species due to the decline in the antioxidant status as authenticated in the present study. These oxygen free radicals could promote the production of inflammatory cytokines and cellular apoptosis. H<sub>2</sub>O<sub>2</sub> stimulates NFκB (transcription factor) that induces TNF-α gene expression. H<sub>2</sub>O<sub>2</sub> stimulates also p38 MAP kinase (p38 mitogen-



**Figure 9:** Photomicrograph of kidney sections from control mouse showing normal COX-2 expression is observed in the proximal and distal convoluted tubules.

**Figure 10:** Photomicrograph of kidney sections from vit E injected mouse showing normal COX-2 expression is observed in renal tubules.

**Figure 11:** Photomicrograph of kidney section from mouse received E102 for 28 days showing increase expression of COX-2 in renal glomerulus and renal tubules.

**Figure 12:** Photomicrograph of kidney section from mouse received E102+vit E showing weak COX-2 immunoreactivity in renal tubules as compared with E102 group (Immunostaining, X400).

### 3.5. Detection of the apoptotic and anti-apoptotic marker activities:

E102 administration caused an elevation of the concentrations of CD95 and caspase-3 in renal tissue recorded 53.97 and 40.18% respectively;

while caused decrease in Bcl-2 immunoexpression levels (38.45%) relative to control group as recorded in Table 3. Vit E injection counteracted E102 side effect on apoptotic marker production where these levels recorded 26.91, 39.38 and 43.18% for CD95, caspase-3, and Bcl-2 respectively.

**Table (3): CD95, Caspase-3 and Bcl-2 levels in control and experimental groups (%)**

	Control	Vitamin E	E102	E102 +Vit E
CD95	35.30±1.56	33.14±5.35	53.97±1.59 <sup>abd</sup>	26.91±2.86 <sup>abc</sup>
Caspase-3	26.45±1.87	27.07±3.28	40.18±2.35 <sup>ab</sup>	39.38±0.77 <sup>ab</sup>
Bcl-2	48.12±0.96	49.41±2.39	38.45±1.45 <sup>ab</sup>	43.18±1.92 <sup>c</sup>

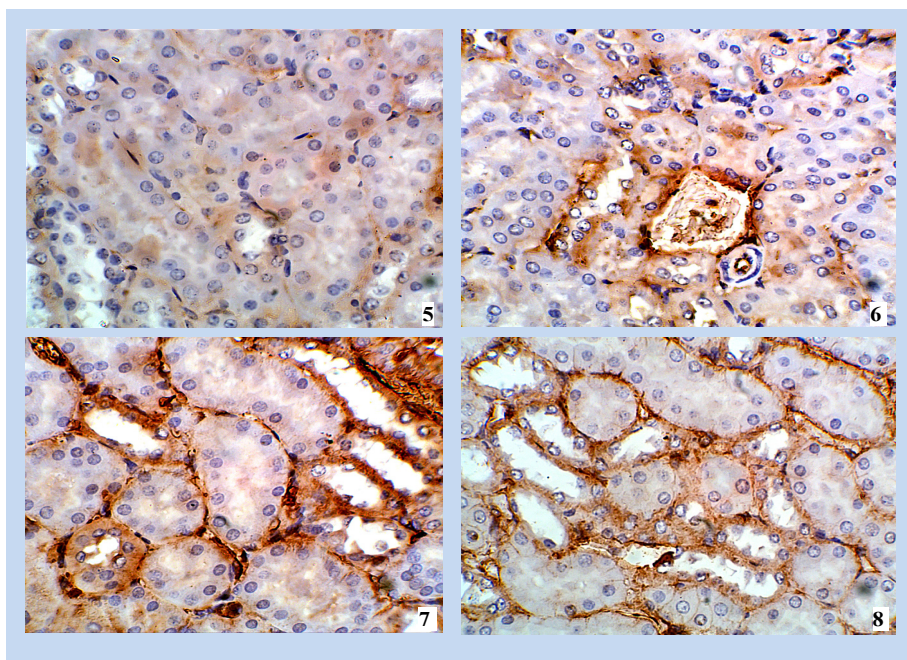
Values are mean ± SD, superscript letters denote the significance; a: significant to C, b: significance to Vit E, c: significant to E102, and d: significant to E102+vit E.

### 3.4. Immunohistochemical Study

#### 3.4.1. Tumor necrosis factor- $\alpha$ (TNF- $\alpha$ )

TNF- $\alpha$  is an inflammatory cytokine produced by macrophages/monocytes during acute inflammation and is responsible for a diverse range of signalling events within cells, leading to necrosis or apoptosis. Cross sections of kidney from control and vit E

injected mice stained immunohistochemically for TNF- $\alpha$  delineated the normal TNF- $\alpha$  expression in the renal tubules (Figures 5 and 6). E102 administration reported an increment expression of TNF- $\alpha$  especially in both proximal and distal tubules and in congested blood vessels (Figure 7). On the other hand, kidney section from mice received E102+vit E showed weak to moderate immunoreactivity for TNF- $\alpha$  in renal tubules as compared with the E102 group (Figure 8).



**Figure 5:** Photomicrograph of kidney sections from control mouse showing TNF- $\alpha$  expression is observed in the proximal convoluted tubules.

**Figure 6:** Photomicrograph of kidney sections from vit E injected mouse showing TNF- $\alpha$  expression renal tubules.

**Figure 7:** Photomicrograph of kidney section from mouse received E102 showing increment expression of TNF- $\alpha$  especially in the proximal and distal convoluted tubules and in congested blood vessels.

**Figure 8:** Photomicrograph of kidney section from mouse received E102+vit E showing weak to moderate immunoreactivity for TNF- $\alpha$  in renal tubules as compared with E102 group. (Immunostaining, X400).

#### 3.4.2. Cyclooxygenase-2 (COX-2) expression

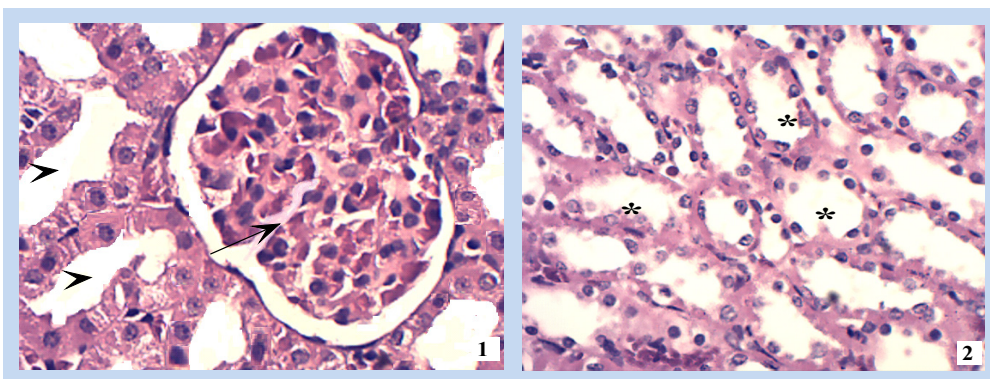
COX-2 is an enzyme responsible for inflammation and pain. Kidney cross sections from control and vit E injected mice showed normal COX-2 expression is observed in the proximal and distal convoluted tubules (Figure 9 and 10). The

administration of E102 for 28 days revealed an increase expression of COX-2 in renal glomerulus and renal tubules (Figure 11). On the other hand, kidney sections from mice received E102+vit E showed weak COX-2 immunoreactivity in renal tubules when compared with E102 group (Figure 12).

### 3.3. Histological Investigation:

Renal tissue sections from control mice illustrated normal architecture of the renal corpuscle and showed rounded glomerulus and glomerular capillaries; proximal

convoluted tubules lined by cuboidal epithelium with narrow lumen in the renal cortex; and distal convoluted tubules with wide lumen (Figure 1). The renal medulla delineated normal architecture of the collecting tubules from mice treated with vit E (Figure 2).

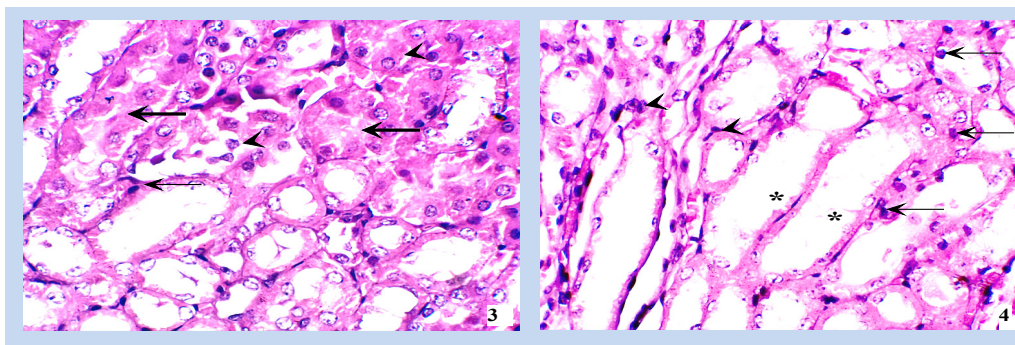


**Figure 1:** Photomicrographs of kidney section from control mouse showing normal architecture of the renal tissue, rounded glomeruli (arrow), distal convoluted tubules with wide lumen (head arrow) and proximal convoluted tubules with narrow lumen lined by cuboidal epithelium in the renal cortex (\*).

**Figure 2:** Photomicrograph of kidney section from vit E injected mouse showing normal architecture of the renal medulla with normal collecting tubules (arrows), (H-E, X 400).

Sections of the kidney from mice administered E102 for 28 days revealed degenerative changes with marginal clumps of heterochromatin and pyknotic nuclei of the epithelial cell of the medulla renal tubules (Figure 3). Despite the short duration of treatment with vit E, it proved its protective effect in improving the renal architecture. Lesions that

appeared as a result of E102 administration were remarkably reduced in the renal tissue sections of the vit E treated mice. Kidney sections from mice that received E102+vit E delineated inflammatory cells invading medulla side by side along the dilated medullary tubules that still have some degenerative and pyknotic nuclei (Figure 4).



**Figure 3:** Photomicrograph of kidney sections from rats received E102 showing degenerative nuclei (head arrows) with marginal clumps of heterochromatin and pyknotic nuclei (thin arrows) of the epithelial cell, hyaline debris (thick arrows) in the lumen of renal tubules of the medulla renal tubules.

**Figure 4:** Photomicrograph of kidney sections from mouse received E102+vit E showing inflammatory cells (arrow) invading medulla side by side along the dilated medullary tubules (\*) that still have some degenerative and pyknotic nuclei (head arrows) (H-E, X 400).

with biotin-labeled anti-mouse IgG, and stained with a streptavidin-peroxidase following the manufacturers guidelines. Positive control slides showed no staining when the primary antibody was omitted.

### 2.6. Determination of apoptotic and anti-apoptotic markers:

The expression of caspase-3, Bcl-2, and CD95 were determined by using FITC anti-caspase-3, anti-Bcl-2 and anti CD95 antibodies respectively; and analyzed on a Flow cytometer equipped with 488 nm Argon laser light source and a 515 nm band pass filter for FITC-fluorescence following the manufacturer instructions.

### 2.7. Statistical analysis:

Data was analyzed using ANOVA by the Statistical

Processor System Support (SPSS) for Windows software, version 16.0 (SPSS, Chicago, IL), and were expressed as mean±standard deviation (SD). A significant t-test (P <0.05) obtained followed by post hoc-least significant difference analysis (LSD).

## 3.RESULTS

### 3.1. Kidney function analysis:

Tar administration of E102 for 28 days, revealed non-significant increase in Na<sup>+</sup> K<sup>+</sup> ions in serum and significant increase in the serum levels of creatinine and urea as evidence of renal damage. These elevations were significantly inhibited in E102+vit E injected mice; which showed decrease levels as compared to the E102 group.

**Table (1): Biochemical analysis of kidney function and electrolytes in control and experimental groups.**

	Control	Vitamin E	E102	E102+Vit E
Na <sup>+</sup> (mEq/L)	141.37±8.8	144.29±9.45	157.19±10.36	153.40±9.12
K <sup>+</sup> (mmol/L)	15.10±2.56	13.01±4.47	16.53±4.12	13.30±3.37
Creatinine (mg/dL)	1.26±0.31	1.06±0.19	2.08±0.50 <sup>abd</sup>	1.28±0.17
Urea (mg/dL)	37.21±2.54	31.39±3.12	45.39±3.45 <sup>ab</sup>	38.22±3.30 <sup>b</sup>

Values are mean ± SD, superscript letters denote the significance; a: significant to C, b: significance to Vit E, c: significant to E102, and d: significant to E102+vit E.

### 3.2. Antioxidant status investigation:

The antioxidant status determined by measurement of reduced glutathione (GSH), glutathione S-transferase (GST), superoxide dismutase (SOD) and catalase (CAT) which reported significant decrease in E102 administered

mice when compared to control and vit E injected mice (Table 2). Co-administration of vit E+E102 delineated significant increase levels in GSH, GST, SOD and CAT levels when compared with E102 group. Levels of malondialdehyde (MDA) reported increase in E102 group compared with control and vit E groups.

**Table (2): Antioxidant status in control and experimental groups.**

	Control	Vit E	E102	E102 +Vit E
GSH (µg/ml)	6.12±0.30	7.00±0.52	4.54±0.29 <sup>abd</sup>	6.07±0.30 <sup>bc</sup>
GST (ng/ml)	0.37±0.02	0.42±0.03	0.29±0.02 <sup>abd</sup>	0.33±0.01 <sup>bc</sup>
SOD (U/ml)	30.42±1.71	33.21±2.73	20.78±2.23 <sup>abd</sup>	27.88±1.36 <sup>bc</sup>
CAT (ng/ml)	48.14±1.43	51.64±2.65	40.35±2.07 <sup>abd</sup>	48.77±1.79 <sup>c</sup>
MDA (ng/ml)	42.31±2.03	29.07±2.45	61.27±3.12 <sup>abd</sup>	48.60±2.62 <sup>ab</sup>

Values are mean±SD, superscript letters denote the significance; a: significant to C, b: significance to Vit E, c: significant to E102, and d: significant to E102+vit E.

E102. This could be considered the first study to evaluate the therapeutic effect of vit E on renal tissue structure, function and antioxidant status as a result of Tar administration, with immunological analysis as follows:

1. Determining the cytokines alterations in renal tissue by evaluating the COX-2, Bcl-2, caspase3, tumor necrosis factor (TNF- $\alpha$ ) expression in the renal tissue.
2. Explore the role of vit E in inhibiting free radical activity and improving kidney function.

## 2. MATERIAL AND METHODS

### 1.1. Experimental animals:

Animals were purchased from Medical Experimental Research Centre (MERC), Mansoura University, Egypt, after approval from the ethical committee and in accordance with guidelines for the proper care and use of laboratory animals (Canadian Council on Animal Care [CCAC], 1993). Twenty-eight Male BALB/c mice strain (weighing 25 $\pm$ 5gm), were used in this study. Animals were left for one week for acclimatization before the beginning of the experiment and kept in an acclimatized room with conventional environmental conditions controlled for temperature and humidity and a photoperiod with timer, respecting the daily cycle of rodents, i.e., 12 hours/day and 12 hours/night. Water was provided in graduated polyethylene bottles placed in metal grids in the upper part of the cages. Food (standard diet) was obtainable throughout the study duration. Mice were divided to 4 groups of 7 mice each. Group1: Mice in this group received distilled water representing the control group. Animals belonging to group 2 received vit E suspended for easily injection in normal saline solution (100 mg/kg bw) subcutaneously. Mice belonging to group 3 received Tar dissolved in distilled water (300 mg/kg bw) orally for 28 days. Mice from group 4 received Tar+vit E for 28 days. At the end of the study, all animals were anaesthetized with diethyl ether to minimize suffering and then sacrificed.

### 2.2. Biochemical analysis:

Blood samples were collected from the heart, left to clot before separating the serum after centrifugation and frozen immediately (-10°C) until used. Serum

level of creatinine, urea, electrolyte Na<sup>+</sup> and K<sup>+</sup> were determined to examine the status of kidney function according to the manufacturer instructions.

### 2.3. Antioxidant status:

The measurement of reduced glutathione (GSH), glutathione S-transferase (GST), malondialdehyde (MDA), superoxide dismutase (SOD) and catalase (CAT) were conducted by using double-sandwich enzyme-linked immunosorbent assay (ELISA) technique. All experiments were conducted according to the manufacture guidelines. The reaction gives a blue product turning into yellow when the stop solution is added. The intensity of the produced color is in proportion to the quantity of mice GSH, GST, MDA, SOD and CAT found in the sample. The optical density was determined with a microplate reader at a wavelength of 450 nm and the values were then read off the standard curve.

### 2.4. Histopathological investigation

Samples of renal tissue were prepared according to histological routine technique. Samples were rinsed with normal saline, after animal scarification. Samples then cut into many small specimens. The specimens then were fixed in formalin (10%), dehydrated with ascending ethanol alcohol concentrations (70% to 100%), cleared in xylene and finally embedded in paraffin wax. Blocks were sectioned at 4 $\mu$ m thickness, stained with hematoxylin and eosin (H-E), and observed under a light microscope for evaluating the histopathological damage, according to Bancroft & Stevens (1990).

### 2.5. Immunohistochemical studies:

Tumor necrosis factor- $\alpha$  (2-TU037-07, quartett, Berlin, Germany) and cyclooxygenase-2 (COX-2) (RB-9072-P0, Thermo Scientific, UK) were expressed in kidney sections. These sections were boiled in microwave for 5 minutes for antigen retrieval. Then treated with 3% H<sub>2</sub>O<sub>2</sub> for 10 minutes at room temperature for blocking of endogenous peroxidase. Using a microwave for 10-20 minutes in 10mM citrate buffer with pH 6.0, to enhance the quality of staining. Slides, were probed with either monoclonal anti-tumor necrosis factor- $\alpha$  (1:100, rabbit Ab), or polyclonal anti-COX-2 (1:100, rabbit Ab). Sections were washed, incubated



## 1. INTRODUCTION

Processed food consumption has increased daily; leading to increase of food dyes production. Synthetic colors are adding to food to make it attractive visually especially for children who are attracted to the brightly colored ice-cream, soft drinks, confections, candies, snacks, jelly, jam, and cereals; hence their consumption levels might be more than adults. E numbers are used as codes for food color additives in the European Union. E numbers start with number 100 and end with the number 199 to include artificial food colors derived from petroleum, and natural additives from vegetables and insects. Although some E number food dyes are not allowed in the European Union or the United State, some are still used illicitly in food products in many countries (Ibrahim & El-Sherbeny, 2016).

Synthetic food colors can be classified as azo-dyes (carmoisine, azorubine, tartrazine, sunset yellow FCF, amaranth, ponceau 4R, allura red AC, brilliant black BN, brown HT, and triarylmethane dyes (König, 2015). Following the passage of the colors Additive Amendment of 1960; about twenty natural colors were exempted from certification, whereas all the approved synthetic colors prior to the amendment were required to be retested if safety doses are questioned. Synthetic food dyes are utilized because of their low cost, coloring properties, uniformity and stability (Ashida, Hashimoto, Tsuji, Kanazawa, & Danno, 2000). Most of these dyes cause toxicity after prolonged utilization, leading to many health problems such as indigestion, anemia, pathological lesions in the liver, kidney, spleen, and brain, cancer, paralysis, allergic reactions, mental retardation, as well as abnormalities in offspring as reported by Moutinho, Bertges, & Assis (2007).

Synthetic food dyes added to promote the external appearance of processed food lead to a lack of intake control of children. Who are attracted to color more easily than adults leading them to consume food additives several times daily in chips, gums, chocolates and soft drinks with no concern about its health effect (Ibrahim & El-Sherbeny, 2016). The nervous system, behavior and organ function are more easily affected in children compared to adults (Moutinho *et al.*, 2007; Ibrahim & El-Sherbeny, 2016; Amin & Al-Sherhi, 2018).

E102 is known as tartrazine or yellow 5, it is most commonly used artificial dyes for foods and drugs (Hashem, Abd-Elhakim, Abo-EL-Sooud, & Eleiwa, 2019). E102 is reduced inside the organism via the intestine and liver to a metabolite recognized as sulfanilic acid by the gut microflora and mammalian azo reductase. E102 is known to produce allergy such as asthma and urticarial, in addition to the confirmation of many studies on its mutagenic and carcinogenic effects (Moutinho *et al.*, 2007; Chequer, Lizier, de Felicio, Zanoni, Debonsi, Lopes, Marcos, & de Oliveira, 2011). When E102 is bio-transformed into aromatic amines, it is oxidized to N-hydroxy derivatives by the enzymatic system of P450 (Demirkol, Zhang, & Ercal, 2012); a mechanism occurs in humans and many species (Chequer *et al.*, 2011), that is responsible for many pathological effects in many organs beside cancer induction. The biotransformation of this azo dye inside the body causes the formation of reactive oxygen species (ROS) such as hydroxyl radical, superoxide anion and H<sub>2</sub>O<sub>2</sub> which formed due to the nitrosamines metabolism and causes oxidative stress and many immunological reactions such as nervousness, general fatigue, clinical depression, purple skin spots, migraines, and disruption in sleep (Bansal, Bansal, Soni, & Bhatnagar, 2005).

The use of vitamins is known to be useful in scavenging free radicals and improving the immunological status of the organisms. Vit E is one of the vitamins that dissolve in fat and known as a powerful antioxidant. Vit E has the ability to reduce oxidative stress and protect the body against reactive oxygen species (Herrera & Barbas, 2001; Traber & Atkinson, 2007). Tocopherols, tocotrienols and  $\alpha$ -tocopherol are fat soluble compounds grouped under the term "Vitamin E" and considered as the most biologically active forms of vit E. Vitamin E is a powerful antioxidant that reduces reactive oxygen species (ROS); ROS can cause a chronic inflammatory response (Herrera & Barbas, 2001). Its mechanism of function is via protecting cell membranes from oxidation by reacting with lipid radicals produced in the lipid peroxidation chain reaction through the glutathione peroxidase pathway (Wefers & Sies, 1988; Traber & Atkinson, 2007).

Due to the unavailable studies on the possible immunomodulatory effect of vitamin E against synthetic food dyes administration such as



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## تغيير السيتوكينات الكلوية (TNF- $\alpha$ ، Cox-2، caspase-3، Bcl-2 و CD95) عن طريق تعاطي صبغة الطعام E102 في ذكور الفئران: التأثير المناعي المحتمل لفيتامين هـ

أمل عطية المرسي إبراهيم<sup>1,2</sup>، سالي عبد الحكيم الشربيني<sup>2</sup>، تركي مبارك الشيخ<sup>3</sup>

(قدم للنشر في 1441/8/29 هـ ؛ وقبل للنشر في 1443/2/28 هـ)

**ملخص:** تعتبر هذه الدراسة الأولى من نوعها لتقييم الدور المناعي لفيتامين هـ لمعالجة التأثير الضار الناتج عن استخدام الصبغات الغذائية، والموجودة في الأغذية المصنعة، عن طريق استحداث الخلل الكلوي في الفئران بحقن الصبغات الغذائية المصنعة بالفم. تم تقسيم حيوانات التجارب إلى 4 مجموعات كالتالي: المجموعة الأولى تمثل المجموعة الضابطة. فئران المجموعة الثانية تعاطت فيتامين هـ (100 مجم/كجم). فئران المجموعة الثالثة صبغة E102 (300 مجم/كجم) لمدة 28 يوم. فئران المجموعة الرابعة تعاطت E102 + فيتامين هـ لمدة 28 يوم.

ظهرت السمية الكلوية المستحدثة في الفئران من خلال التغيرات في مستويات وظائف الكلى، وحالة مضادات الأكسدة. بينما أدى تعاطي فيتامين هـ لتحسين مستويات وظائف الكلى (الشوارد والكرياتينين والبورينا) وحالة مضادات الأكسدة والدلائل المناعية (TNF- $\alpha$  و Cox-2 و caspase-3 و Bcl-2 و CD95). أثبتت الدراسة الحالية الدور العلاجي والمناعي لفيتامين هـ ضد سمية صبغة الطعام E102 والتي تعزى إلى آثاره المضادة للأكسدة وخصائص إزالة الجذور الحرة.

**الكلمات المفتاحية:** الفئران، الخلل الكلوي، صبغة الطعام E102، مضادات الأكسدة، فيتامين هـ.

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## Alteration of Renal Cytokines (TNF- $\alpha$ , Cox-2, caspase-3, Bcl-2, and CD95) by E102 Food Dye Administration in Male Mice: Possible Immune Modulation by Vitamin E

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(Received 23/4/2020; Accepted 6/10/2021)

**Abstract:** This could be considered first study that concerned with evaluation of the immunomodulatory effect of vitamin E (vit E) against renal cytokines alteration induced by synthetic food dyes in male mice. Mice were divided into 4 groups; mice in group 1 were the control, animals in group 2 received vit E (100mg/kg bw), group 3 mice administered E102 (300mg/kg bw), and mice from group 4 received E102+vit E for 28 days.

Nephrotoxicity in mice was confirmed by assessing changes in levels of the renal markers and antioxidant status. Co-administration of vit E resulted in restoration of altered levels of renal functions (electrolytes, creatinine & urea), antioxidants status and different cytokines (TNF- $\alpha$ , Cox-2, caspase-3, Bcl-2, and CD95). The therapeutic role of vit E against E102 food dye-induced nephrotoxicity could be attributed to their antioxidant effects and free radical scavenging properties.

**Keywords:** Mice, Nephrotoxicity, Food dye E102, Antioxidant, Vitamin E.



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### 3.4. Effect of clay content on molecular weight

Figure 7 illustrates the relationship between simulated values of molecular weight (Mw) and clay contents of sPP/Clay composites. It depicts molecular weight increases gradually with increasing the clay contents. This is related to the fact of the relaxation time of the polymer and polymer composites (Wolfgang Thimm, 1999). In other words, samples with higher molecular weight

(higher clay content) takes more time to recover its initial conformation. It shows clay contents affect not only microstructure properties, but also all chain dynamics. The above simulated result can be verified from a previous work (Naveed Ahmad E. F., 2017) by matching the cross-over frequency of the master curves (Relaxation time) and simulated molecular weights of the sPP/Clay composites. It shows sPP/Clay composite of higher clay contents have molecular weights.

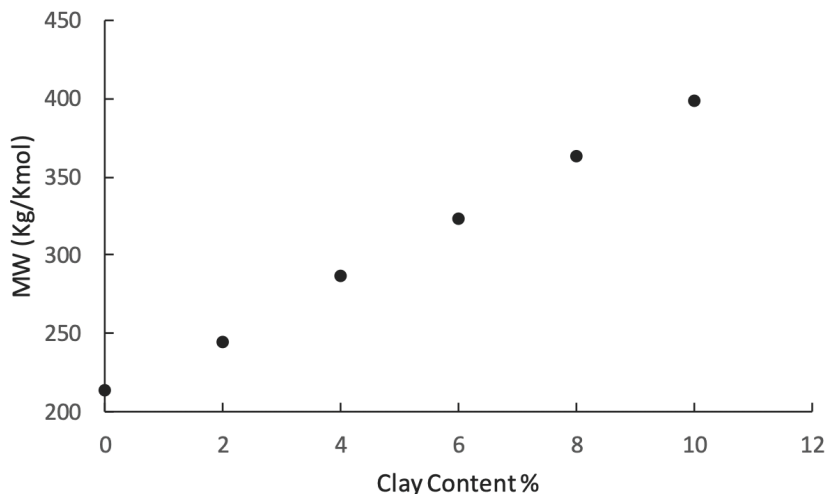


Figure 7: Relation between molecular weight and clay contents of sPP/Clay composites.

## 1. CONCLUSION

The study of thermodynamic and molecular weight gives broad information about the properties of the materials in both macromolecular and molecular level. Thermodynamic properties and molecular weight are significantly influenced by the re-enforcement phase. In this research, thermodynamic properties and molecular weight were simulated by using HYSYS software and then examined as a function of clay contents. Critical temperature indicates the thermal stability and intermolecular forces, which affect

the mechanical strength of polymer composite that is influence by the re-enforcement. Critical volume and eccentricity significantly increase with increasing the clay contents. As a result, thermodynamic information can be used to predict both the macromolecular and molecular properties of any polymer and polymer composite. Also, it was found the sample with higher clay content have molecular weight due to the relaxation time, which can be verified by matching the cross-over frequency of the master curves (Relaxation time) of the samples and simulated molecular weights of the same samples.

### 3.2. Effect of clay content on critical volume

Critical volume depends upon on the amount of material under observation (B. J. Taylor, 2009). Critical volume for all the sPP/Clay samples were estimated. The relationship between critical

volume and clay contents for sPP/Clay composites are shown in Figure 5. It narrates an increase in clay contents increases critical volume, which is coherent with the available work in literature (B. J. Taylor, 2009). Increase in clay contents increases the quantity of polymer.

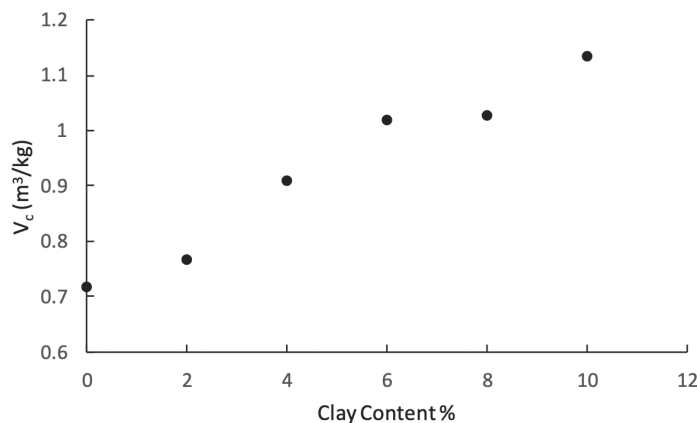


Figure 5: Relation between critical volume and clay contents of sPP/Clay composites.

### 3.3. Effect of clay content on eccentricity

Eccentricity is the measure of the organization of crystals or monomers of a material (Mohamed F. M. Fahmy, 2016). Eccentricity for all sPP/Clay composites were simulated. The linear relationship between eccentricity and clay contents is shown for all the sPP/Clay composites in Figure 6. An increase in clay contents

increases eccentricity. This is related to fact that clay contents increase the crytallinity of sPP/Clay composite and hence eccentricity. This can be further justified from the melting points of sPP/Clay composites. The sPP/Clay composite of higher clay contents have higher melting point, which reflects the fact sPP/Clay composites of higher clay contents, monomers are regularly arranged and hence more energy is required to melt it.

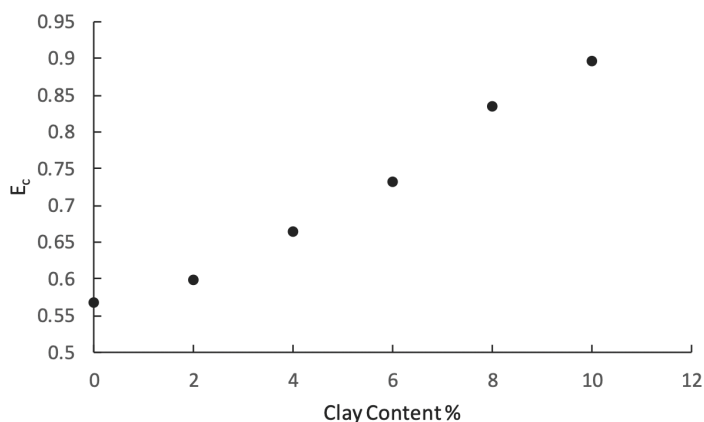


Figure 6: Relation between eccentricity and clay contents of sPP/Clay composites.

The influence of clay content on the critical temperature reflects two main findings; thermal stability and intermolecular forces which affect the mechanical strength of sPP/Clay composites. For more explanation, these two finding can be verified from previous work (Naveed Ahmad E. F., 2017). First, an indication of the relationship

between clay content and plateau modulus (elastic modulus) that shows the mechanical response of the sPP/Clay composites. As a result, Figure 3. shows the relationship between plateau modulus (Elastic modulus) and critical temperature. Samples with higher clay contents have higher plateau modulus and critical temperatures.

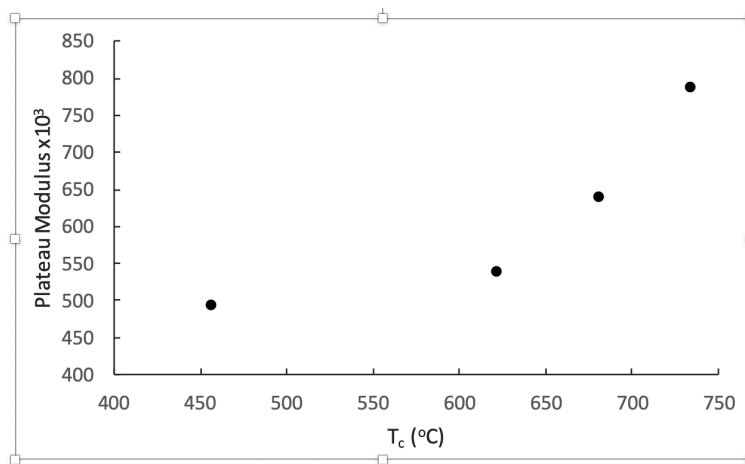


Figure 3: Relation between plateau modulus (Naveed Ahmad E. F., 2017) and critical temperature (T<sub>c</sub>) of sPP/Clay composites.

Secondly, thermal stability can be verified by investigating the impact of critical temperatures on the melting points of the sPP/Clay composites as explained in Figure 4. The

samples with higher melting points have higher critical temperatures. Indicating the fact that both are affected by clay content and to each other.

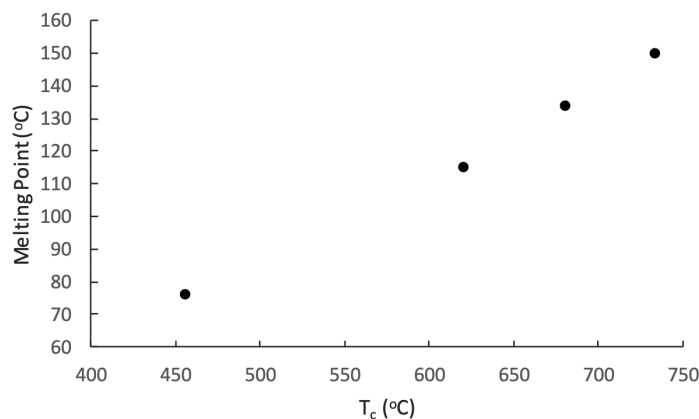


Figure 4: Relation between melting point (Naveed Ahmad E. F., 2017) and critical temperature (T<sub>c</sub>) of sPP/Clay composites.

### 3. RESULTS AND DISCUSSION

Table 1. shows the estimated critical temperature, critical volume, eccentricity and molecular weight of sPP/Clay composites, which were

examined as a function of clay content. It was noticed clay contents have significant influence on the thermodynamics properties and molecular weight of the sPP/Clay composites.

**Table 1. estimated molecular weight and thermodynamic properties of a set of sPP/Clay composites**

Sample No.	Clay Content %	$T_c$ (°C)	$V_c$ (m <sup>3</sup> /Kg)	$E_c$	M.WT (kg/kmol)
1	0	455.25	0.71743	0.56697	213
2	2	519.94	0.76552	0.59877	244
3	4	568.75	0.90925	0.66431	286.43
4	6	620.49	1.01946	0.73268	323.75
5	8	680.12	1.02625	0.83588	362.96
6	10	733.06	1.13488	0.89633	398.52

#### 3.1. Effect of clay content on critical temperature

Critical temperature was found to increase gradually with an increase in the clay contents as shown

in Figure 2. Increase in the critical temperature indicates the energy requirement to reach the critical point which is related to the thermal strength of the sPP/Clay.

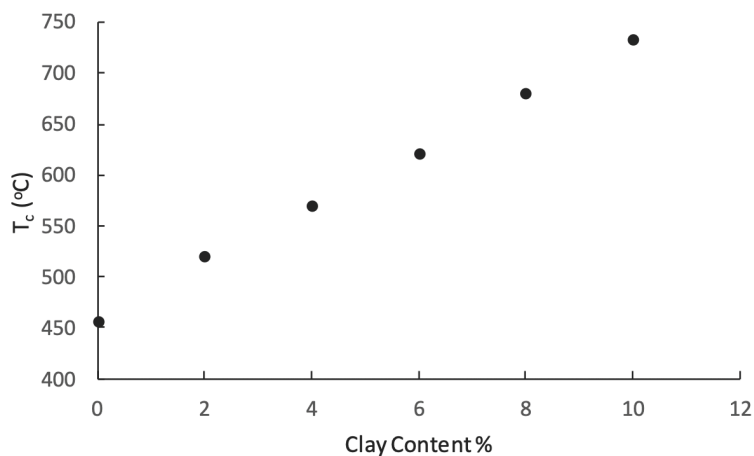


Figure 2: Linear relation between the amount of clay content and the critical temperature ( $T_c$ ) of sPP/Clay composites



## 2. METHODOLOGY

Molecular weight and thermodynamic properties include critical temperature ( $T_c$ ), critical volume ( $V_c$ ), and eccentricity ( $E_c$ ) were estimated using HYSYS software for a set of sPP/Clay composites with different clay loading ranging from 0% to 10% with step size of 2%. The pure and composite of polymer and clay are not available in the library components of the HYSYS. Hypothetical components are created in the simulation basis manager. HYSYS can estimate the thermodynamic properties and the molecular weight (output data) once we provide the normal boiling point and

density (input data) to the software for each sample. Figure 1 shows the procedure of the simulation. Before installing the hypothetical components, an estimation method is selected for calculating the unknown properties (Diana-Carolina Cruz-Forero, 2012). In our work, we use a default method that has different models to estimate the thermodynamic properties and molecular weight based on the supplied data (normal boiling point and density). Les-Kesler, Bergman and Cavett models were used to estimate the critical temperature and molecular weight (ChangjunLi, 2012). Pitzer model was used to calculate the Critical volume and Eccentricity (Z. Bakher, 2018).

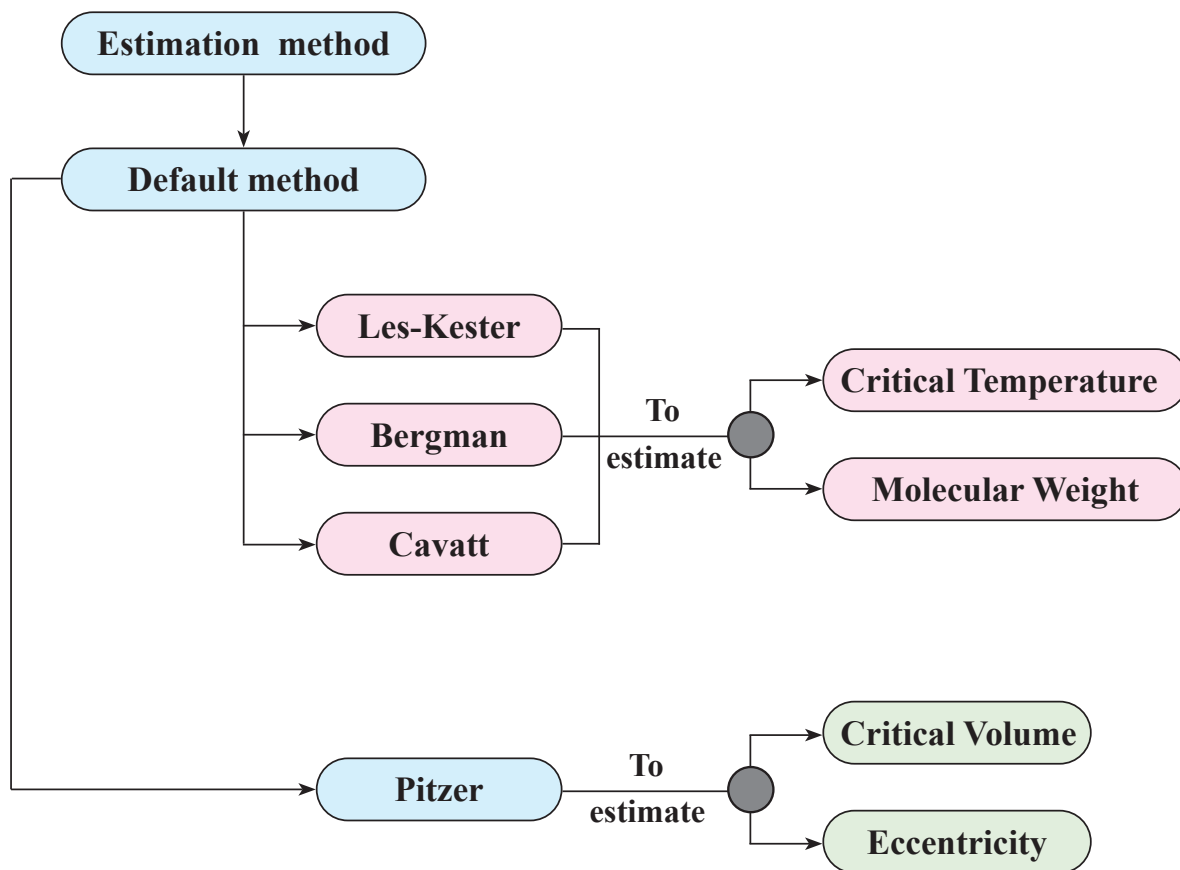


Figure 1: The procedure of simulation in HYSYS software

## 1. INTRODUCTION

Polymer composites have been extensively used in daily life which include: packaging, transportation, medical, agricultural, electrical, construction and consumer applications, due to their direct and indirect final properties including mechanical, physical, rheological, thermal and thermodynamic properties (Daniel J. Arriola, 2006; Gibson, 2006; Abbas Ghanbari, 2013; Gourav Kumar Jatav, 2013; Fredrickson, 1996; L. J. Fetters, 1994; Al-Thani, Bhadra, & Zadeh, 2015). Therefore, they are rapidly replacing some metals because of different characteristics that make composites flexible in several industrial applications (Abbas Ghanbari, 2013; Gourav Kumar Jatav, 2013). As a result, it is significant to estimate and study all final properties that can be enhanced with variation in the re-enforcement phase (A. Eckstein, 1998; Jose M. Carella, 1984; Sedigheh Bagheri-Kazemabad, 2012; Madhuchhanda Sarkar, 2008; Yuanqing Xiang, 2006; Chenyang Liu, 2006). However, it is difficult to directly measure some of these properties such as thermodynamic properties that are affected by re-enforcement content. Several researches have been made to study the relationship between the re-enforcement phase and final measured properties of polymer and polymer composites.

The rheological properties (plateau modulus and entanglement molecular weight) of syndiotactic polypropylene (sPP) having different degrees of syndiotacticity were explored (Naveed Ahmad, 2013). They found a rise in the plateau modulus with increase in the syndiotacticity of sPP. However, this type of investigation is still not conducted for many polymers and polymer composite systems. Researchers studied rheological and thermal properties of polymer/clay gels and multilayered films using atomic capillary expansion rheometer (ACER), differential scanning calorimetry (DSC), and thermal gravimetric analysis (TGA) and relate them with the micro structural properties of composites and films (Stefanescu, 2008). In his study, polyethylene oxide and montmorillonite clay was used as a composite. He found a gradual

increase in both storage and loss modulus with an increase in the clay contents. (Naveed Ahmad E. F., 2017) carried out research to study the relation between clay contents and the rheological parameters (plateau modulus and entanglement molecular weight) of syndiotactic polypropylene/Chines bentonite clay composites. They noticed enhancing clay contents amplify the plateau modulus and consequently diminish entanglement molecular weight. They concluded the clay contents of polymer/clay composites affect chain dimensions, parameters, and consequently all dynamics. Recently, the effect of thermodynamic factors on the wood/plastic composites was investigated (Niarki & Krause, 2019; Pouria Rezaee Niaraki, 2020). They prepared the composites by melting plastics at 180 °C and dispensing it on wood surfaces. They related contact angle and found an increase in the wood contents decreases the contact angle. They also found applying sanding makes lower surfaces free energy and higher interfacial shear strengths on the polymer/wood interface. They noticed higher temperatures, wetting of composites, is caused by polymer properties instead of interfacial tension at the polymer/wood interface.

A review of present available literature depicts copious research has been conducted on the synthesis, thermal and rheological properties of polymer and polymer/clay composites. However, the influence of clay contents on thermodynamic properties including critical temperature ( $T_c$ ) critical volume ( $V_c$ ) eccentricity ( $E_c$ ) of polymer/clay composites has not been estimated using any software. Therefore, this research, HYSYS software was used to estimate these thermodynamic properties and explore the link between clay contents and thermodynamic properties of sPP/clay composites. This research is an extension and validation of previous research work, which explained the relation between clay content and rheological properties (Naveed Ahmad E. F., 2017), and therefore, illustrates the relation between the clay content and molecular weight and thermodynamic properties of the sPP/clay composite samples.



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# محاكاة الخصائص الديناميكية الحرارية والوزن الجزيئي لمركبات الايروبولي بروبيلين/الطين المتماثل (sPP/clay) باستخدام برنامج الهايسس HYSYS

عبدالعال زهير الخزعل

(قدم للنشر في 1442/3/10 هـ ؛ وقبل للنشر في 1442/10/9 هـ)

**ملخص البحث:** اكتشاف الوزن الجزيئي والخصائص الديناميكية الحرارية لمواد البولي اوليفن المركبة مطلوبة لفهم التركيب الجزيئي والمستوى النوعي الذي يؤثر على التطبيقات الحرارية النهائية . في هذا البحث، تم استخدام برنامج الهايسس HYSYS لتقدير الوزن الجزيئي والخصائص الديناميكية الحرارية بما في ذلك درجة الحرارة الحرجة (Tc) والحجم الحرج (Vc) والاختلاف المركزي (Ec). بالإضافة إلى ذلك، تم دراسة تأثير محتوى الطين على الخواص الديناميكية الحرارية والوزن الجزيئي. لقد تم استخدام مجموعة من عينات مركب الايزوبولي بروبيلين/الطين المتماثل (sPP/clay) مع تغير مادة التعزيز (التقوية) (الطين الصيني) بين 2 و 10 % . تم الوصول إلى أن الخصائص الديناميكية الحرارية والوزن الجزيئي للعينات تتزايد بشكل ملحوظ مع تزايد المحتوى الطين. هذا العمل البحثي هو التحقق من صحة حقيقة أن محتويات الطين تؤثر على كل من الخصائص المجهرية والميكروسكوبية (الديناميكا الميكانيكية وديناميكا السلسلة) لمركبات البوليمر المتماثلة.

**كلمات مفتاحية:** هاييسس HYSYS، درجة الحرارة الحرجة، الحجم الحرج، الوزن الجزيئي، الاختلاف المركزي.

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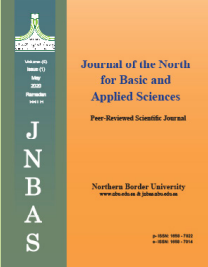


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## Simulation of Thermodynamic Properties and Molecular Weight of sPP/Clay Composites using HYSYS Software

Abdulaal Zuhayr Al-Khazaal

*(Received 27/10/2020; Accepted 21/5/2021)*

**Abstract:** The investigation of molecular weight and thermodynamic properties of polyolefin composites is needed to provide a better understanding of the macromolecular and molecular level affect on final thermal applications. HYSYS software was used to estimate molecular weight and thermodynamic properties including: critical temperature ( $T_c$ ), critical volume ( $V_c$ ) and eccentricity ( $E_c$ ) for sPP/clay composites, moreover, the influence of clay content on thermodynamic properties and molecular weight was investigated. A set of sPP/clay composite samples was used with a variety of re-enforce material (Chinese clay) between 2 % and 10%. It was found increased clay content led to a gradual increase in thermodynamic properties and molecular weight of samples. This investigation validates the fact clay contents affect both the macroscopic and microscopic (mechanical and chain dynamics) properties of the polymer composites.

**Keywords:** HYSYS, critical temperature, critical volume, molecular weight, eccentricity.

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## Nomenclature

$N$  the number of the day in the year

$\varphi$  latitude of the location.....degree

$\theta$  the Incident angle ..... degree

$I_{sc}$  solar constant .....  $W.m^{-2}$

$I_o$  the average daily extraterrestrial solar irradiance .....  $W.m^{-2}$

$\delta$  the declination angle ..... degree

$\omega_s$  hour angle ..... degree

$I_{od}$  the daily total direct normal extraterrestrial radiation.....  $W.m^{-2}$

$IBF$  the fraction of the extraterrestrial radiation

$F_c$  the monthly correction factor

$\bar{H}_T$  the monthly daily average total irradiation on a horizontal surface .....  $W.m^{-2}$

$H_{oT}$  the total extraterrestrial radiation on a horizontal surface .....  $W.m^{-2}$

$\rho$  water density.....  $kg.m^{-3}$

$C_p$  specific heat ..... $J.kg^{-1}.^{\circ}C^{-1}$

$A$  area .....  $m^2$

$x$  depth .....m

$T$  temperature.. .....  $^{\circ}C$

$Q_{su}$  absorbed heat of solar radiation in the upper zone.....  $W.m^{-2}$

$Q_{wu}$  heat loss from the sides in the upper zone.....  $W.m^{-2}$

$Q_{bu}$  heat gained from the bottom in the upper zone.....  $W.m^{-2}$

$Q_{uc}$  heat loss by convection in the upper zone.....  $W.m^{-2}$

$Q_{ur}$  heat loss by radiation in the upper zone.....  $W.m^{-2}$

$Q_{ue}$  heat loss by evaporation in the upper zone.....  $W.m^{-2}$

$Q_{su}$  absorbed heat of solar radiation in the storage zone.....  $W.m^{-2}$

$Q_{sw}$  heat loss from the sides in the storage zone.....  $W.m^{-2}$

$Q_{sb}$  heat loss from the bottom in the storage zone.....  $W.m^{-2}$

$Q_{st}$  heat loss from the top in the storage zone.....  $W.m^{-2}$

$Q_{se}$  heat loss by heat extraction in the storage zone.....  $W.m^{-2}$

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After achieving this high level of accuracy in the performance of the multi-script Matlab program, comparing the outcomes with field results in several regions, and calculating the performance of the solar pond with high accuracy, this study was applied to the University of Northern Borders in Arar in the Kingdom of Saudi Arabia with all climate variables and solar radiation

in the region considered. The model was built to simulate these conditions and case studies. The results showed a considerable rise in the temperature inside the solar pond compared to the air temperature (represented in Figure 8). The salinity gradient solar pond temperature may reach more than 75°C in the storage zone during the summer peak.

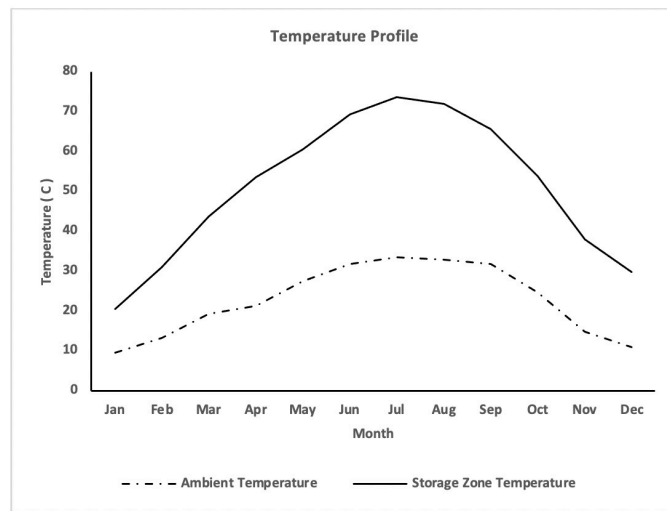


Figure 8: Predicted temperature profiles for the storage zone and ambient in NBU Solar Pond.

## 5. CONCLUSIONS:

Solar ponds in hot regions are extremely useful for their multiple purposes, such as heating in the winter season, water desalination and electricity generation in the summer seasons. The apparent benefit of utilizing solar pond technology may be the low cost of construction and operation and maintenance, as their construction could be as low as \$5 per square meter. This study proved that there is great compatibility between NASA solar radiation data and these models' outcomes, at least for these four examined locations. It is found that temperatures in Northern Border University can reach 75°C based on 0.4m thickness of

the gradient zone, which makes using the solar pond in desalination with a multi-effect evaporation unit extremely productive since the MEE units can operate at 60°C. If the NCZ is thicker, the storage zone temperature can be higher accordingly. The investigation illustrated that Arar city receives 95% more irradiation than London and higher than many locations in the world, which means higher solar pond performance than any of the reported SGSPs that recorded more than 100°C. In the second year of the operation, each month will be of a higher temperature by at least 12%, and the bottom and side insulation could raise the temperature higher to 60°C even during the winter season.

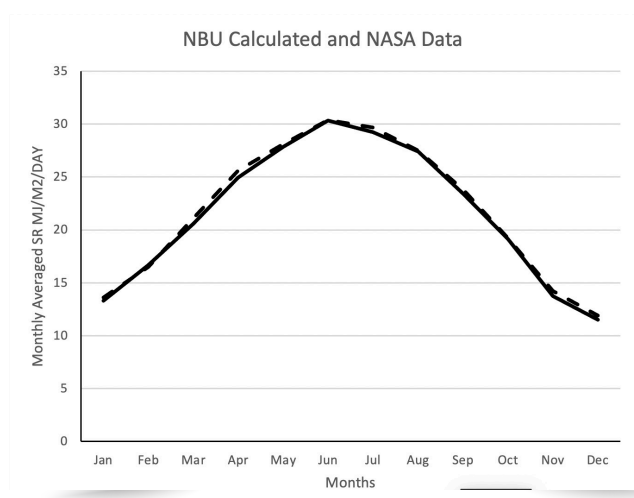


Figure 6: The present model predictions for NBU location compared with NASA data of solar insolation.

The single input Matlab script is utilized in this study to simulate any solar pond performance in the world, giving precise results. This model is tested and compared with given data by Ali (1986) under similar weather conditions such

as ambient temperature, wind speed, humidity, the amount of solar radiation etc. The outcome of the multi-script Matlab and the Kuwait solar pond performance temperature profile is shown in Figure 7.

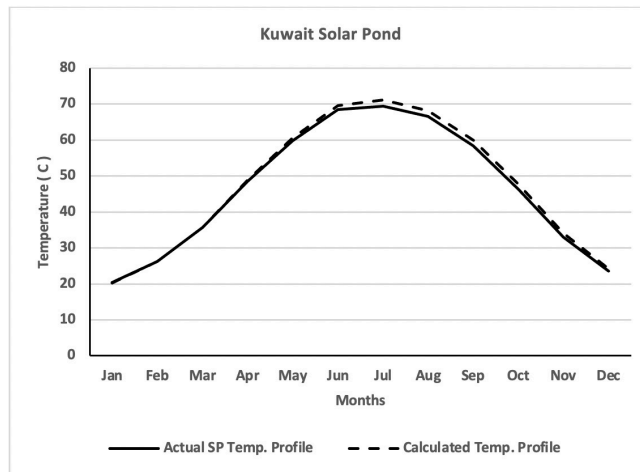


Figure 7: The present prediction and the actual field data of the Kuwait solar pond.



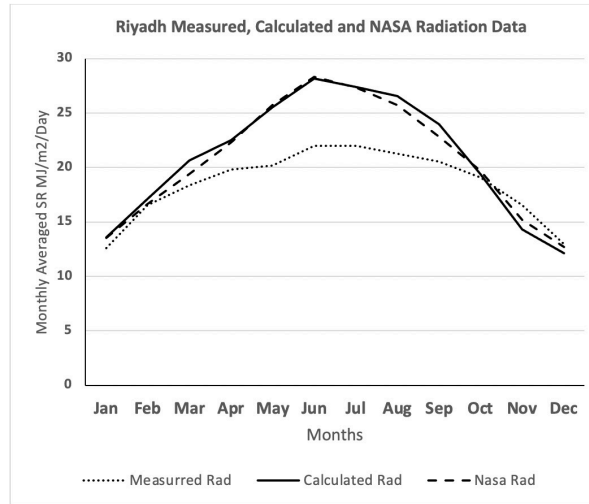


Figure 4: The present model predictions for the Riyadh region compared with the measured and NASA data of solar insolation.

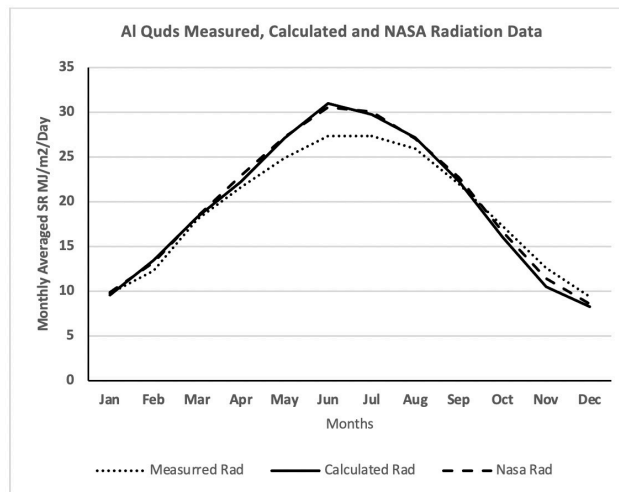


Figure 5: The present model predictions for the Al Quds region compared with measured and NASA data of solar insolation

After validating the model in the different locations in the Middle East with the available measured data, the radiation calculation model has been applied to predict Northern Border University insolation

(located in Latitude 30.8492; Longitude 41.196) and is compared with NASA records for the year 2020. This comparison shows an extremely close profile, as plotted in Figure 6.

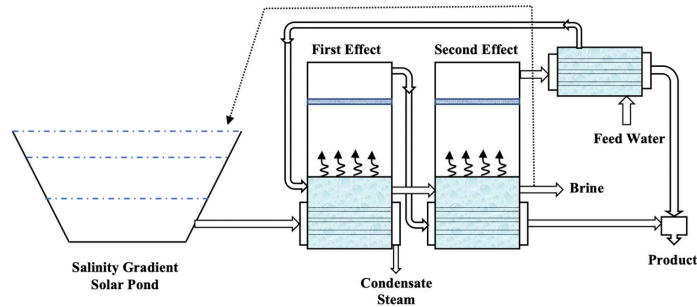


Figure 2: MEE powered by SGSP

#### 4. RESULTS AND DISCUSSIONS:

The single input calculation program has been developed and used for estimating the solar irradiation in Kuwait, Riyadh, and Al Quds, chosen as three different locations in the Middle East region. It collected available measured data of certain years for these three cities. NASA has been recording the solar radiation for these three locations and others for more than 30 years. The output of this script is validated with NASA averaged monthly measurements data, and the results provide a reliable matching at least for the randomly investigated locations. These measured and NASA data are utilized to test and validate the outcomes' accuracy of the Matlab model. The comparison solar irradiation study result for

Kuwait is illustrated in Figure 3, showing the field measurement that NASA records and the model calculation output data are in very good agreement. The results of the mathematical model estimation and NASA recording data for Riyadh give excellent matching, while the site measurement was far from both as shown in Figure 4. This divergence in the values between the measurements in the field and NASA records and the results of the calculations gives a clear impression of the importance of this model's multi-scripts program calculations because it shows the error in the field measurements as a result of climatic conditions, human errors, or device reading errors for that year. Al Quds' three solar radiation records and calculations data are also summarized in Figure 5, giving considerable reliable matching as well.

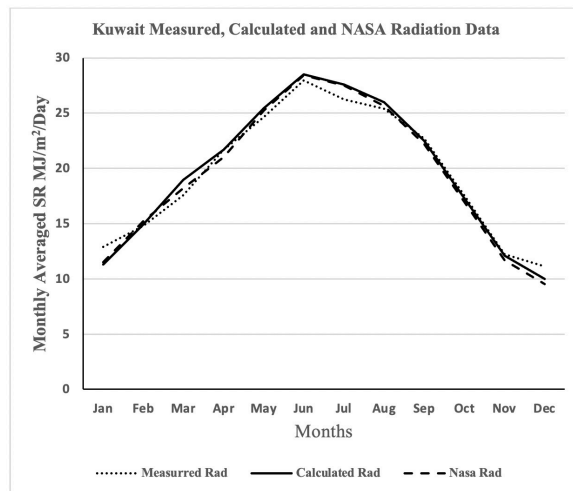


Figure 3: The present model predictions for the Kuwait region compared with the measured and NASA data of solar insolation.

$$IBF = \frac{1.5\varphi - 14.25}{\varphi} Fc \quad (4)$$

Fc is a predicted monthly correction factor validated accurately for the Middle East with

$$\bar{H}_T = IBF(\bar{H}_{oT}) \quad (5)$$

The equation of Kreider and Kreith (1982) is a well-known formula in solar radiation, which was extensively explained earlier in Lunde (1982) based on the amount of sunlight scattering by the clouds (the clearness index). Nevertheless, the index here is replaced by the predicted factor IBF that can be easily computed by relating the field solar radiations data with longitudes via a specialized kind of computer program.

The steady-state model for the solar pond has been widely accepted and recommended by the most

NASA's published date, and the above equation can be applied in the following formula:

famous research references in the SGSP area, such as Weinberger (1964), Rabl and Nielsen (1975), Kooi (1979), Ali (1986), Wand and Akbarzadeh (1983), and many other researchers. In the present model, for simplicity, the downward one-dimensional flux model is being utilized.

In the present model, it is assumed that both the upper and lower convective zones are well mixed such that the lumped system model can be applied. Therefore, the steady-state energy equation for the upper layer is represented by:

$$\rho_u C_{pu} A x_u \frac{u u}{dt} = Q_{sru} + Q_{ub} - Q_{uc} - Q_{ur} - Q_{ue} \quad (6)$$

This solar radiation computation program requires only a latitude value to predict sunrise, sunset, and sunshine periods to compute the solar radiation equations. A new predicted empirical equation has been added to this script to give a good agreement and it has been tested for three different locations in Middle Eastern countries. The incident solar radiation values, which are based on monthly average daily amounts, can be obtained from the available

references or the 30-year average values which are recorded on the NASA website (NASA, 2020).

In the present model, the middle salinity gradient layer is considered as a conduction slab and the thermal amount of the solar insolation absorbed by this slab is consumed to build and maintain the gradient temperature profile in this non-convecting layer. The storage zone steady-state energy equation will be:

$$\rho_s C_{ps} A x_s \frac{u s}{dt} = Q_{srs} - Q_{st} - Q_{sb} - Q_{sw} - Q_{se} \quad (7)$$

Further details about each parameter in equations (6) and (7) were extensively discussed by Lunde (1982), Rabl and Nielsen (1975), and Ali (1986). Model validation is probably the most crucial and essential step in the model-building stages. In the present study, model validation is accomplished via comparing the present predictions with a previous study that was carried out in Kuwait (Ali, 1986). The heat of the solar pond at the Northern Border University can be used for space heating, water heating, and desalination. It reported that many

multi-effect desalination plants can operate under 60°C; for example, the Trapani desalination plant in Italy and the Eilat MEE plant in Aqaba Gulf have been working since 1992 at an operating temperature of 55°C. Other MEE plants in the UAE are manufactured to produce water vapor at a top brine temperature (TBT) of 58.5°C (Al-Sham, 1999). A multi-effect evaporation (MEE) plant powered by a salinity gradient solar pond is illustrated in Figure 2. Further details about coupling MEE with SGSP was investigated by Alenezi (2012).

$$H_{oT} = \frac{I_{od}}{\pi} \left[ \cos \varphi \cos \delta \sin \omega_s + \frac{2\pi\omega_s}{360} \sin \varphi \sin \delta \right] \quad (2)$$

In the above relations, the value of  $I_{od}$  represents the direct normal extraterrestrial solar radiation daily and can be easily computed by obtaining the value

of extraterrestrial solar radiations radiating from the sun throughout the whole day by leveraging the above-mentioned relation as:

$$I_{od} = 24I_o \quad (3)$$

In order to utilize these equations for computing the value of the monthly daily average total extraterrestrial solar radiations on a horizontal surface, the month representative-

day is required and can be easily computed by making use of Lunde (1982) apart from other useful equations in the calculation of solar radiations.

Table 1: Days and Numbers of a Year and the Representative-Day for Each Month

Month	N for i <sup>th</sup> day	Date	N Day of Year
Jan	i	17	17
Feb	31+ i	16	47
Mar	59+ i	16	75
Apr	90+ i	15	105
May	120+ i	15	135
Jun	151+ i	11	162
Jul	181+ i	17	198
Aug	212+ i	16	228
Sep	243+ i	15	258
Oct	273+ i	15	288
Nov	304+ i	14	318
Dec	334+ i	10	344

Matlab computation software has been adopted to build up a multi-scripts program for solving ordinary differential equations by finite difference methods for steady state models. This program takes into account the changes of boundary conditions

and surround factors with different periods of time. The new empirical equation that works with the available solar radiation equations to estimate the solar radiation based on the single input parameter is as follows:

### 3. MATHEMATICAL MODELLING:

The solar heat absorption inside a salinity gradient pond or any mass of water on the earth is highly affected by the site location. The sun's path through the sky continuously changes, thus the altitude of the sun's rays, the azimuth angle and the daily sunshine period from sunrise to sunset are varied. These changes may have a significant effect on the amount of the incident solar irradiation which, consequently, would affect the performance of any solar collector (Kalogirou, 2014). The solar irradiation data has been widely measured and recorded for almost every location in each country in the world over a long period of time. Nevertheless, the estimations and calculations of the sun's irradiation are sometimes required for the prediction of a good approximation of the irradiation amount in a certain location based on the latitude and attitude.

The estimation of the solar radiation can be mathematically performed in several time periods,

such as every hour or day; however, it is found monthly averaged data modelling is the most effective method for representing the climate variation and its calculations (Duffie & Beckman, 2006; Ali, 1986). The daily or hourly measurements and calculations may vary considerably from year to year, and such ways of estimation are quite limited for giving a general impression about weather data. On the other hand, seasonal recording and yearly data collections would definitely not be accurate enough to represent any type of climate computations (Ali, 1986). Thus, based on the given reasons, the average monthly measurements or calculations have been adapted in this study.

Since the average distance between the earth and sun varies significantly during each season in the same year, the apparent extraterrestrial solar radiation also changes. Therefore, the intensity of solar radiation relies on the number of days of the year. The extraterrestrial solar radiation can be computed by modifying the model of Adel, Hazim and Alenezi, (2011):

$$I_o = I_{sc} \left[ 1 + 0.033 \cos \left( \frac{360N}{370} \right) \right] \quad (1)$$

At the beginning of the 20<sup>th</sup> century, many scientists performed numerous experiments to measure the value of the solar constant ( $I_{sc}$ ). After Abbot (1965) and his co-researchers at the Smithsonian Institute conducted many years of research, they deduced the value of the solar constant to be 1353 W/m<sup>2</sup>.

Based on Abbot's research, further investigations were conducted based on the ground-base and high-altitude measurements to compute the most precise and accurate value of the solar constant ( $I_{sc}$ ). With the consent of all the researchers, 1353 W/m<sup>2</sup> is universally accepted as the standard value for the solar constant (Abbot, 1965).

NASA has also conducted various experiments to precisely measure the most accurate value of the solar constant ( $I_{sc}$ ) using the most sophisticated

measuring tools and techniques. NASA has suggested the value of the solar constant, which was already discussed in Garg (1982).

Recently, NASA's official website has disclosed that NASA has publicly endorsed the value of 1368 W/m<sup>2</sup> as the standard value for the solar constant, which is closer to the universally accepted standard value. NASA has managed to deduce the value of 1368 W/m<sup>2</sup> as the only acceptable value of solar constant through the aid of its satellite, which has measured the average variation of incident solar radiation on a year to year basis (NASA's official website, 2020).

The daily total extraterritorial solar radiations radiating from the sun on a horizontal surface can be easily computed via the aid of the following relation:

sunlight, convert it into heat energy, and store heat for long periods. This heat can be used for heating buildings, electricity generators, and thermal desalination plants. Many of the available commercial techniques, such as thermoelectric cell (TEC), are quite reliable at lower than 90°C for electricity generation, which is suitable with the salinity gradient pond (Mittal, Singh, & Singh, 2020). The normal mass of water absorbs the sunlight and converts it to heat energy, thus the temperature increases at the bottom. The water molecules at the bottom gain heat and become lighter, which then

move to the surface under the effect of the convective phenomenon. The non-convecting pond suppresses the convective behavior because of the salinity gradient in the middle layer, and the connecting only happens within the lower layer.

## 2. THE PRESENT MODEL:

A typical salinity gradient solar (SGS) pond consists of three layers, illustrated in Figure 1, and is modeled in the present work.

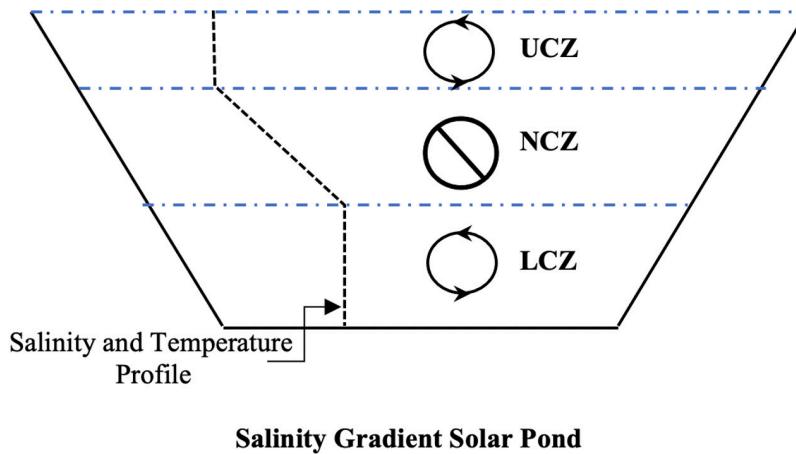


Figure. 1. Salinity and temperature profiles through the salinity gradient solar pond zones.

### The present SGS pond consists of three zones:

1. The Upper Convecting Zone (UCZ): This layer's thickness would be typically about 30cm. It should be thin enough to allow for sunlight penetration and prevent the middle layer from climate effects such as evaporation, wind movement influence, and others. The UCZ has the least salinity, lowest construction cost, and the temperature usually varies very closely to the ambient temperature.
2. The Non-Convecting Zone (NCZ): This gradient layer is located in the middle between the upper and lower water layers; however, both temperature and salinity increase with depth in the layers inside this zone, thus it is a heterogenous region. This downward increment profile of temperature and salinity is supposed

to prevent the water molecules from obeying the convection phenomenon even at the high temperature records. The optimum thickness of this layer is proposed to be between 0.4 and 0.8m, depending on the pond size (Batty, Riley, & Bhise, 1986 and Alenezi, 2012).

3. The Lower Convecting Zone (LCZ): This lower homogenous zone has the highest temperature and the most salinity concentration in the pond. The collected heat from solar irradiation is stored in this lower region and can be exchanged either inside the pond or delivered outside the SGSP. The thickness of the LCZ can be any depth; however, this significantly affects the amount of heat storage and the temperature variation. As the thickness increases, the heat storage capacity increases and the temperature tends to be more stable.

## 1. INTRODUCTION:

Northern Border University spends a considerable amount of money on space heating and providing drinking water. The need for drinkable water increases during the hot weather as use of the solar pond at this time is considered more effective.

The solar pond (SP) is a unique system for collecting and storing free solar irradiation, which is a renewable and environmentally friendly source of energy. The need to use clean energy and reduce the use of fossil fuel energy increases due to the negative impact of the latter on the environment and to reduce the cost on saving energy.

Renewable energy is energy obtained from unlimited and renewable sources of power, such as solar irradiation, wind, geothermal, waterpower, biomass, and tidal energy. The need for using renewable energy is increasing day by day as an alternative to traditional energy powered by non-renewable sources. The major non-renewable energy sources include fossil fuel, coal, and natural gas, which are mainly obtained from underground long-period accumulative stores formed over millions of years. The emissions produced from burning fossil fuel, coal or natural gas for energy generation purposes have accumulated negative impacts on the environment, whereas renewable energy is considered to be an environmentally friendly source. Moreover, traditional fuels will deplete in the future and the world authorities must switch to renewable sources as soon as possible.

Sunlight is an extremely powerful source of energy, particularly in the desert regions of the earth, like Saudi Arabia where the sun intensively radiates for most days of the year. For example, according to National Aeronautics and Space Administration (NASA) data in the year 2020, the average annual irradiation in Arar, Saudi Arabia is 5964 Wh/m<sup>2</sup>.day, Wh/m<sup>2</sup>.day in London, UK and 3408 Wh/m<sup>2</sup>.day in Paris, France. This means the irradiation in Arar is 95.7% higher than London, and 75% higher than Paris. Extraterrestrial sunlight travels from the sun toward the earth with enormous energy. Part of this light is reflected by the earth's atmosphere, another part is scattered by the clouds and suspended as

materials in the air, and approximately half of the sunlight reaches the surface of the planet. The light received by the earth's crust could be either direct or diffused beams, can be useful for providing heat.

Solar radiation is one of the most promising renewable energy sources. Currently, there is no evidence indicating this source produces greenhouse emissions into the earth's atmosphere or causes any substantial harmful impact on nature. Solar energy technologies can be classified into two main types based on the way of utilizing the energy: direct and indirect solar radiation collectors. The flat plate collector (FPC) is an example of indirect solar devices that absorb solar beam by a blackened absorber and transfers it to a transport medium in fluid tubes to be stored away or immediately used. On the other hand, the salinity gradient solar pond (SGSP) is one of the solar direct collectors that directly transfers the solar beam into heat.

The first natural temperature gradient reported due to water salinity was by Kalecsinsky in the Medve Lake, Transylvania in 1902. The pond was self-formed in 1875 as a result of collapsing a salt mine. The salinity gradient was then naturally built. The heat inside Medve Lake gradually increased until the temperature reached 80°C (Dickinson & Cheremisinoff, 1980; Kreider & Kreith, 1981; Duffie & Beckman, 2006). This observation encouraged the researchers to investigate and construct a SGSP led by Weinberger and Tabor in 1964 (Dickinson & Cheremisinoff, 1980; Lu et al., 2004). Despite the research efforts motioned by Tabor, non-convective solar ponds were constructed in several countries, including Israel (1975), USA (1975), Kuwait (1980), India (1987), Italy (1997), and Australia (2000). At least two of these ponds experienced pond destruction because of reaching boiling temperature. The experimental results of these ponds were recorded, and mathematical models were developed (Duffie & Beckman, 2006; Lu et al., 2004). The experimental studies concluded the thermal efficiency of small ponds can reach 21% in peak seasons (Shah, Arshad, Khoss., Ali, & Ali, 2019).

The salinity gradient pond is simple, clean, and powered by the free source energy technique. It could be a unique and simple system that can collect



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## تحليل أداء بركة شمسية لأغراض التدفئة وتحلية المياه بموقع جامعة الحدود الشمالية

إبراهيم العنزي

(قدم للنشر في 1441/8/12 هـ ؛ وقبل للنشر في 1442/9/20 هـ)

**ملخص:** تعد تكنولوجيا الطاقة الشمسية واعدة بدرجة كبيرة في البلدان ذات المناخ المشمس الحار مثل المملكة العربية السعودية حيث يسجل الإشعاع الشمسي أحد أعلى المستويات في العالم. يمكن للبركة الشمسية المتدرجة الملوحة أن تحول أشعة الشمس مباشرة إلى طاقة حرارية بتكلفة منخفضة. تم تطوير النموذج الرياضي أحادي البعد لحلة الثبات لاستخدام مدخل واحد لحساب متغيرات الإشعاع ويمكنه الاستفادة من معادلات الحرارة لمحاكاة بركة شمسية ثلاثية المناطق وللتنبؤ بخصائص أدائها. تقع هذه البركة في موقع جامعة الحدود الشمالية في عرعر بالمملكة العربية السعودية. تم التحقق من صحة النموذج الحالي من خلال مقارنة تنبؤاته بأداء بركة شمسية متدرجة ملوحة حقيقية وأظهرت المقارنة مطابقة موثوقة. أظهرت التوقعات الحالية أنه خلال فصل الشتاء، لا يزال بإمكان البركة الشمسية توفير مياه ساخنة بدرجة حرارة لا تقل عن 30-40 درجة مئوية من منطقة التخزين السفلى، بينما في مواسم الصيف قد تتجاوز درجة الحرارة 75 درجة مئوية حتى تصل إلى نقطة الغليان.

**كلمات مفتاحية:** البرك الشمسية، النظم الشمسية، تدفئة المباني، تحلية المياه.

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## Performance Analysis of Solar Pond for Heating and Desalination Purposes Sited in Northern Border University, Saudi Arabia

Ibrahim Alenezi

*(Received 6/4/2020 ; Accepted 2/5/2021)*

**Abstract:** Solar energy technology is extremely promising in countries with hot-sunny climates, such as Saudi Arabia, where solar radiation records are one of the highest levels in the world. The salinity gradient solar pond can directly convert the sun's rays into heat energy with considerable low cost. The one-dimensional steady state mathematical model has been developed to use a single input for calculating the irradiation variables, can utilize the heat equations to simulate a three zones' solar pond and for predicting its performance characteristics. This pond is located at the Northern Border University Site in Arar, Saudi Arabia. The present model was validated by comparing its predictions with the performance of a real salinity gradient solar pond and the comparison showed reliable matching. The present predictions showed during the winter season, the solar pond could still provide hot water with a minimum temperature of 30-40°C from the lower storage zone while in the summer seasons, the temperature may exceed 75°C until it could reach boiling point.

**Keywords:** Solar pond, Thermal solar system, Space heating, Desalination .

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2. The researcher's CV, including his/her full name in Arabic and English, current work address, email, and academic rank.
3. The researcher must fill out and submit the application for publishing in the Journal of the North, along with the Pledge Statement that his/her submission has not been published before or has not been submitted for publishing elsewhere.

## NB

1. The submissions received by the Journal of the North will not be returned whether they are published or not.
2. The published papers reflect only the author's points of view.
3. All accepted manuscripts devolve their property to *the Journal of the North for Basic and Applied Sciences (JNBAS)*.

# PUBLICATION INSTRUCTIONS FOR AUTHORS

## Submission Guidelines

1. Manuscript must not exceed 35 pages of plain paper (A4).
2. Manuscript must have a title and an abstract in both Arabic and English on one page; the abstract should not be more than 250 words. The manuscript should include, in both languages, keywords that indicate the field of specialization. The keywords are written below each summary and should not be more than six.
3. The author(s) name(s), affiliation(s) and address(es) must be written immediately below the title of the article, in Arabic and English.
4. The Arabic manuscript is typed in Simplified Arabic, in 14-font size for the main text, and 12-font size for notes.
5. The English manuscript is typed in Times New Roman, in 12- font size for the main text, and 9-font size for notes.
6. The manuscript is typed only on one side of the sheet, and line spacing should be single. Margins should be 2.5 cm (or 1.00 inches) on all four sides of the page.
7. The manuscript must have the following organization:
  - Introduction:** It should indicate the topic and aims of the research paper, and be consistent with its ideas, information and the established facts. The research problem(s) and importance of the literature review should also be introduced.
  - Body:** The manuscript body includes all necessary and basic details of research approach, tools and methods. All stated information should be arranged according to priority.
  - Findings and Discussion:** Research findings should be clear and brief, and the significance of these findings should be elucidated without repetition.
  - Conclusion:** It is a brief summary of the research topic, findings, recommendations and suggestions.
8. Figures, diagrams and illustrations should be included in the main text and consecutively numbered and given titles, with explanatory notes beneath them.
9. Tables should also be included in the main text, consecutively numbered and given titles at the top, with explanatory notes below.
10. Footnotes should be added at the bottom of each page, when necessary. They are to be indicated by numbers or asterisks, in 12-font size for Arabic and 9-font size for English.
11. The Journal of the North does not publish research and measurement tools (instruments). However, they must be included in the submission(s).
12. Citations must follow the American Psychological Association (APA) reference style in which both the author's name and year of publishing are mentioned in the main text, i.e. (name, year). Numbering the references inside the main text and adding footnotes are not allowed.

Researchers' documentation must be as follows:

  - For single author, the author's family name, followed by a comma, and the publishing year, such as (Khayri, 1985). Page numbers are indicated in the main text in case of quotations, such as (Khayri, 1985, p. 33).
  - If a manuscript has two authors, they must both be cited as shown previously, e.g. (AL-Qahtani & AL-Adnani, 1426 H).
  - If there are multiple (more than two) authors, their family names must be mentioned the first time only, e.g. (Zahran, Al-Shihri, & Al-Dusari, 1995); if the researcher is quoting the same work several times, the family name of the first author followed by "et al." [for papers in English] and by "وأخرون" [for papers in Arabic] must be used, e.g. (Zahran et al., 1995) / (1995، زهران وأخرون) Full publishing data must be mentioned in the bibliography.
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14. The bibliography, list of all the sources used in the process of researching, must be added in alphabetical order using the author's last name according to the APA reference style (6<sup>th</sup> edition) in 12-font size for Arabic and 9-font size for English.

**The bibliography should be organized as follows:**

**Citation from books:**

**Citation from a one-authored book:**

Shotton, M. A. (1989). *Computer education? A study to computer dependency*. London, England: Taylor & Francis.

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The Journal of the North is concerned with the publication of original, genuine scholarly studies and researches in Basic and Applied Sciences in Arabic and English. It publishes original papers, review papers, book reviews and translations, abstracts of dissertations, reports of conferences and academic symposia. It is a biannual publication (May and November).

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The journal seeks to achieve leadership in the publication of refereed scientific papers and rank among the world's most renowned scientific periodicals.

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The mission of the journal is to publish refereed scientific researches in the field of Basic & Applied Sciences according to well-defined international standards.

## Objectives

1. Serve as a scholarly academic reference for researchers in the field of Basic & Applied Sciences.
2. Meet the needs of researchers, publish their scientific contributions and highlight their efforts at the local, regional and international levels.
3. Participate in building a knowledge community through the publication of research that contributes to the development of society.
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1. Originality, innovation, and soundness of both research methodology and orientation.
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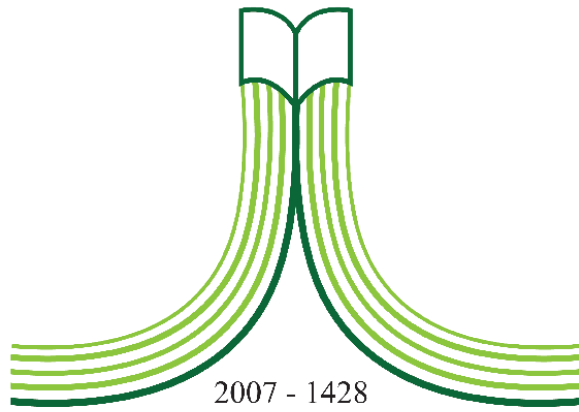
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