Online ISSN: 2249-4626
Print ISSN: 0975-5896
DOI: 10.17406/GJSFR

Global Journal

of Science Frontier Research: D

Agriculture & Veterinary



Evaluation of Pasteurization

Smart Agronomy of Wheat Cultivation

Highlights

Natural and Organic Farming

Investigation of Major Diseases

Discovering Thoughts, Inventing Future

VOLUME 22 ISSUE 2 VERSION 1.0

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Volume 22 Issue 14 was originally issued as D2

Global Journal of Science Frontier Research: D
Agriculture & Veterinary

Volume 22 Issue 14
Originally issued as D2

Global Journal of Science Frontier Research: D
Agriculture & Veterinary

Volume 22 Issue 2 (Ver. 1.0)

Open Association of Research Society

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Global Journal of Science Frontier Research: D
Agriculture and Veterinary
Volume 22 Issue 2 Version 1.0 Year 2022
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-460x & Print ISSN: 0975-587X

Evaluation of Pasteurization and Sterilization Process on Camel Milk Quality

By Sara M. B. Mohamed Elhassan & Ibtisam E. M. El Zubeir
Omdurman Islamic University

Abstract- Pasteurization and sterilization processes were applied on camel milk and their effect on its quality were evaluated in this study. Camel milk was subjected to the pasteurization and sterilization process using the USPTO UHT+ S1 pilot plant and was examined for its compositional components before and after conducting of heat treatment. The results indicated non-significant ($P>0.05$) variations between the fresh and both the pasteurized and sterilized camel milk in the mean values of total solids (TS), solids not fat (SNF), fat, free fatty acids (FAA), lactose, protein, casein, urea, citric acid, pH, density and acidity after immediate application of heat treatment and also during the storage period. However, significant ($P\leq0.05$) differences were found in the pH and the freezing point depression (FPD) of the pasteurized milk and the FFA and the acidity of the sterilized milk compared to the raw milk. Moreover, the physicochemical properties of camel milk products showed stability during two weeks of storage at four degree centigrade for the pasteurized milk and room temperature (37°C) for the sterilized milk. The total bacterial count and coliform were significantly ($P\leq0.05$) reduced in the pasteurized and sterilized camel milk.

Keywords: *camel milk, pasteurization, sterilization, bacterial loads, shelf life.*

GJSFR-D Classification: *DDC Code: FIC LCC Code: PZ7.C7834*



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Evaluation of Pasteurization and Sterilization Process on Camel Milk Quality

Sara M. B. Mohamed Elhassan [α] & Ibtisam E. M. El Zubeir [σ]

Abstract- Pasteurization and sterilization processes were applied on camel milk and their effect on its quality were evaluated in this study. Camel milk was subjected to the pasteurization and sterilization process using the USPTO UHT+ S1 pilot plant and was examined for its compositional components before and after conducting of heat treatment. The results indicated non-significant (P>0.05) variations between the fresh and both the pasteurized and sterilized camel milk in the mean values of total solids (TS), solids not fat (SNF), fat, free fatty acids (FAA), lactose, protein, casein, urea, citric acid, pH, density and acidity after immediate application of heat treatment and also during the storage period. However, significant (P≤0.05) differences were found in the pH and the freezing point depression (FPD) of the pasteurized milk and the FFA and the acidity of the sterilized milk compared to the raw milk. Moreover, the physicochemical properties of camel milk products showed stability during two weeks of storage at four degree centigrade for the pasteurized milk and room temperature (37°C) for the sterilized milk. The total bacterial count and coliform were significantly (P≤0.05) reduced in the pasteurized and sterilized camel milk. Furthermore, non-significant (P>0.05) differences were recorded for sensory properties between the two products, whereas the panelists accepted the pasteurized and sterilized products from camel milk. This work concluded that both pasteurized and sterilized camel milk products are safe, compositionally rich in components and with acceptable and relatively long shelf life. Moreover camel milk processing will be one of the profitable industrial products in the future.

Keywords: camel milk, pasteurization, sterilization, bacterial loads, shelf life.

I. Introduction

Pastoralism is important to many people in Africa as it is a way of life, which is based on raising different livestock including cattle, small ruminants, and camels (Tilahun *et al.*, 2017). Sudan economy is highly dependent on selling the live animals to Egypt as a source of meat by the pastoral nomads "*Abbala"* or by exporting the raising and sports camels to Saudia Arabia and the gulf countries (Yousof and El Zubeir, 2018). According to FAOSTAT (2021), the estimation of camel population during 2019, the Sudan is rated second highest world size of camel population in the world; after Somalia; with population of more than 5 million heads.

Camel milk has unique benefits for human health because of its remarkable properties in terms of its proteins in addition to its richness in vitamin C, manganese, iron, unsaturated fatty acids, immunoglobulin, insulin-like protein, and the protective enzymes like lactoferrin, and lysozyme (Mohammad-abadi, 2020). Camel milk could be one of the future promising industrial products due to its unique properties (El Zubeir, 2015; Abdullahi, 2019; Ali *et al.*, 2019). Despite its merits among the pastoralists, still the camel milk is facing with various problems such as high postharvest quantity losses, and quality deterioration (Oselu *et al.*, 2022). Moreover, camel milk is reported to be contaminated by some spoilage, and pathogenic microorganisms (Shuiep *et al.*, 2007; Shuiep *et al.*, 2009; Benyagoub *et al.*, 2013; Mohamed and El Zubeir, 2014; Elhosseny *et al.*, 20018). This situation necessitates the introduction of some safe method of preservation like pasteurization, however good manufacturing practices has to follow to ensure public health (El Zubeir, 2015). Mohamed and El Zubeir (2014) found that the heat treatment of camel milk was efficient in reducing the microbial loads, and the increase of the shelf life of the product. Nevertheless, raw camels' milk, compared to cows' milk, has more shelf life at room temperature, and if heat treatment is applied, it can stay stable for a longer time (El Zubeir, 2015).

Wernery (2007) demonstrated that many camel milk components were more resistant to heat than cow's milk. Moreover, Wernery *et al.* (2003) found that pasteurization process (72°C for 5 minutes) has no effect on fat, protein, β-lactoglobulin, minerals (zinc, iron, calcium, and copper), and vitamins (A, E, B1, B2, B6, D3, C, and pyridoxal) of camel milk. However, significant (P≤0.05) decrease was reported in the pH, protein, and lactose contents, while the acidity was increased due to the increase in heat treatment for camel milk (Elhasan *et al.*, 2017). Moreover, some countries like India and the United Arab Emirates have started the industrial production of pasteurized camel milk (using 74°C for 15 seconds) commercially; the product secured a shelf life of about 15 days in the refrigerator (Yadav *et al.*, 2014). However, the processing of camel milk is rarely adopted in the countries owning the high numbers of camels due to many constraints, including socioeconomic aspects.

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The heating of camel milk is not commonly practiced among pastoralist in Sudan because they believe that camel milk is produced ready cooked from the udder (El Zubeir, 2015). Hence awareness programs are needed among the consumers on the health risks that might occur when raw milk is consumed (Warsma and El Zubeir, 2015). Therefore, it is aimed in this study to investigate the effect of pasteurization and sterilization treatments on camel milk properties, and to get safe products from camels with longer shelf life.

II. Materials and Methods

a) Source of camel milk

Two batches of fresh camel milk (thirty liters, each) were collected from a local camel herd that browsed the natural pasture of Green Valley at the Eastern Nile of Khartoum State, Sudan in August 2018. The milk samples were kept cool in an icebox, during their transportation for processing.

b) Processing of pasteurized and sterilized camel milk

In this study, the camel milk was made into pasteurized and sterilized products. The two experiments were conducted spartanly in the Products Promotion Unit of DAL Food's Company (CAPO) at Khartoum North, Sudan.

Both pasteurization and sterilization processes of camel milk were conducted using the USPTO UHT+ S1 pilot plant (Germany). Camel milk was first preheated at 55°C under homogenization pressure (160 Bar) before applying of the pasteurization and sterilization process. The temperature used for pasteurization was fixed at 78°C for 15 seconds, and that used for the sterilization was 137°C for 4 seconds. The data for evaluation of the milk after application of the heat treatments was obtained immediately after pasteurization and sterilization and during the storage (on the 3rd, 7th, 10th, and 14th days) for the pasteurization, and sterilization process. Each batch (n= 2) of heat-treated camel milk products was examined four times for the chemical compositional content.

c) Chemical analysis of the pasteurized and sterilized camel milk

In the present study, the chemical analysis of camel milk samples was determined using the milk analyzer Milkoscan FT2, FOSS Analytical A/S.69 according to the manufacture instructions (Slangerug-gade, and DK3400 Hillerod, Denmark). The chemical composition of camel milk that were examined include the total solids (TS), solids not fat (SNF), fat, free fatty acid (FFA), lactose, protein, casein, urea, citric acid (CA), density, acidity, and freezing point depression (FPD). Meanwhile the pH meter was used for the determination of the pH. The measurements for the chemical analysis of camel milk included raw milk, immediately after heat treatments and on the 1st, 3rd, 7th, 10th, and 14th days while storing of the pasteurized and sterilized products.

d) Microbial loads of processed camel milk

The total bacterial counts in fresh, pasteurized, and sterilized camel milk were determined using the plate count agar medium according to the method described by Houghtby *et al.* (1992). Meanwhile, the coliform bacterial count was estimated in the same samples using violet red bile salt agar medium (Christen *et al.*, 1992).

e) Sensory evaluation of processed camel milk

The obtained pasteurized and sterilized camel milk products were subjected to the assessment by 20 semi-trained panelists that belong to DAL Food's Company (CAPO). They evaluated the following sensory attributes for the 2 products: appearance, aroma, immediate taste, flavor, taste, after taste, and acceptance of the overall product. Each attribute was evaluated by the semi trained panelist according to the differences among the preference scales (Like very much, like moderately, like slightly, neither like nor a dislike, dislike slightly, dislike rather and dislike very much) for respect to the scores given. Furthermore, the differences in the judgment between the pasteurized and the sterilized products of camel milk were calculated.

f) Statistical analysis of the data

The analysis of variance (ANOVA) by IBM SPSS statistics (version 22) was conducted in the present study using Complete Randomized Design with four replicates. The means were compared and separated using Duncan's Multiple Range Test. Moreover, the Student t-test was used for sensory evaluation data.

III. Results and Discussion

a) Physio-chemical properties of pasteurized camel milk

The average mean values for the pasteurized camel milk samples revealed 3.9±0.09% for fat, 11.0±0.18% TS, 7.5±0.12% SNF, 1.4±0.098% FAA, 3.7±0.07% lactose, 2.4±0.04% protein, 1.5±0.05% casein, 570.2±16.65 mgL^{-1} urea, 0.11±0.005% citric acid, 1.025±0.000 gm/cm^3 density, 0.2±0.007% acidity, 6.5±0.013 pH and 466.6±72.81 m° C FPD (Table 1). The obtained values were approaching those reported for the means of total solids (10.80–11.19%), SNF (7.31–7.54%), fat (3.62–3.86%), lactose (3.58–3.72%), protein (2.37–2.45%), casein (1.469–1.557%) and density (1.024–1.025 gm/cm^3) of camel milk samples subjected to the heat treatment of pasteurization process (Hessain *et al.*, 2013). Also, the obtained values for the unsaturated fatty acids (Table 1) supported Al–Shamsi *et al.* (2018) who stated that camel milk has a higher amount of unsaturated fatty acids compared to bovine milk. Moreover, Dowelmadina *et al.* (2018) reported that the fatty acids composition of camels' milk from Arabi

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ecotypes in Sudan confirmed the nutritional and health interest of camel's milk. They added that the fatty acids composition and types of camel milk seems to be very different from that of other mammalian milk consumed by humans due to their lower content of long-chain fatty acids. Also, higher values were reported for urea concentration in camel milk (Table 1, 2, 3) compared to the values mentioned for camel milk in Kazakhstan, which gave a mean value of 81.6±60.4 $mg{\cdot}L^{-1}$ and a range of 0–290.5 $mg{\cdot}L^{-1}$ (Faye *et al.*, 2010).

The data in Table 2 showed non-significant ($P>0.05$) variations in the values of the TS, SNF, lactose, fat, FFA, protein, casein, urea, citric acid, density, and acidity of pasteurized camel milk during the storage periods. Similarly, heating camel milk at either 63°C for 30 minutes, 72°C for 15 seconds, or 78°C for 15 seconds showed no effect ($P>0.05$) on the levels of SNF, lactose, fat, and density of camel milk (Hessain *et al.*, 2013). Hence using heat treatment to improve camel milk quality, and to extend its shelf life is recommended (Hessain *et al.*, 2013). Moreover, the indirect boiling of camel milk did not affect its Physio-chemical properties, while the direct boiling was found to cause an increase in the total solids, lactose, ash, density, and casein contents. In contrast, it decreased the whey protein of milk from camel (Mohammed and El Zubeir, 2016). Also, with an increasing heat treatment applied for camel milk, no effect was found in SNF, fat, and density. In contrast, a significant ($P\leq0.05$) decrease was found for protein, lactose, and the pH, and a significant ($P\leq0.05$) increase was reported for the level of the acidity (Elhasan *et al.*, 2017). However, higher significant variations were found in the protein and total solids of camel milk during heat treatment at both 80°C/30 minutes and 90°C/30 minutes, while the fat content was not affected (Hattem *et al.*, 2011). Moreover, Elhasan *et al.* (2017) reported variable results for the physic-chemical content of milk samples obtained from cows, goats, sheep, and camels according to the differences in heat treatments to which the milk was subjected. The present results supported the conclusion that it is possible to produce pasteurized camel milk (Ipsen, 2017).

The obtained pH values of fresh (6.4±0.024) and the pasteurized camel milk samples (6.5±0.013) were significantly ($P\leq0.05$) different (Table 1). Similarly, Mohamed and El Zubeir (2014) found a gradual increase of lactic acid in the raw and heat-treated milk samples from camel during their storage. The present finding was also in line with those which indicated that the pH of fresh camel milk was in a range of 6.4 and 6.7 (Singh *et al.*, 2017) or 6.2 to 6.5 (Abdullahi, 2019). Also, Elhasan *et al.* (2017) found that the mean value of the pH of camel milk samples subjected to heat treatment was 6.6.

The freezing point depression was 466.6±72.81 and 618.9±18.62 for the fresh and pasteurized camel milk samples, respectively (Table 1). The freezing point depression of camel milk revealed values between 570 and 610 or -0.57 and -0.61C (Ipsen, 2017). Moreover, the freezing point depression was found to show a significant ($P\leq0.05$) reduction immediately after the pasteurization process. At the same time, it revealed non-significant ($P>0.05$) variation at the end of the storage period (Table 2).

b) Physio-chemical properties of sterilized camel milk

The values obtained for the sterilized camel milk revealed 3.6±0.08% for fat, 11.0±0.25% TS, 7.7±0.16% SNF, 1.6±0.127 m°C FAA, 3.8±0.083% lactose, 2.5±0.07% protein, 1.6±0.07% casein, 542.0±15.65 mgL^{-1} urea, 0.10±0.006% citric acid, 0.2±0.008% acidity, 6.5±0.006 pH, 1.025±0.001 gm/cm^3 density and 608.3±24.09 m°C FPD (Table 1). More or less similar values for TS, fat, SNF, lactose, protein, acidity, pH and density were reported previously for the fresh raw camel milk (Shuiep *et al.*, 2008; Babiker and El Zubeir, 2014 and Mohamed Elhassan *et al.*, 2015).

The results indicated non-significant ($P>0.05$) variations between the values of TS, SNF, lactose, fat, protein, casein, urea, citric acid, density, and the pH of the sterilized camel milk during the storage periods (Table 3). Meanwhile, the obtained values of FAA and the acidity of camel milk (Table 1) were significantly ($P\leq0.05$) different between the sterilized and the fresh raw products. However, Elhasan *et al.* (2017) found variations in the physic-chemical characteristics of camel milk after sterilization at 121°C. Also, Hattem *et al.* (2011) stated that usually the milk processors face challenges when applying UHT treatment of camel milk due to the heat resistance of its casein, whey proteins, vitamins and fat globules, in addition to some other compounds. Similarly, He *et al.* (2020) reported that the ultra-high-temperature treatment of camel milk was found to reduce the levels of its proteins and lactose significantly. Pasteurization of the camel milk in its final package was tried previously using direct and indirect UHT treatment (150 °C/2 seconds and 138 °C/4 seconds, respectively) at the pilot scale (Farah *et al.*, 2007). Short shelf live was obtained for the UHT from camel milk (Table 3). This might be because of the difficulty of obtaining UHT from camel milk.

Table 3 illustrated that sterilized camel milk has short shelf life, which indicated the difficulty of securing UHT from camel milk. The reason might be because in this study, the UHT product was packed into the bottles that were usually used for the pasteurized milk. Hence we recommend that Tetra back containers should be used in the future studies on sterilized camel milk. Also, the sedimentation of protein and short shelf life (5 weeks only) under refrigeration conditions suggested that mild UHT treatment of camel milk is not suitable (Ipsen, 2017). The origin of these deposits is the camel milk proteins, which is due to the low quantities of free thiol groups in comparison to that from bovine milk

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(Konuspayeva and Faye, 2021). Thus more research is needed to solve the problem of instability before introducing the UHT and sterilization treatments at the industrial level (Ipsen, 2017). This especially because of the benefit from the camel milk product that will be gained by many of the milk producers and retailers due to the extended storage period at the shelf without refrigeration (Oselu *et al.*, 2022).

c) *The bacterial count of pasteurized and sterilized camel milk*

The data in Figures 1a and 1b showed a significantly ($P \leq 0.05$) higher total bacterial count in raw fresh camel milk than in pasteurized (51.4±13.3 CFU vs. 6.3±1.3 CFU) and sterilized (60.1±9.4 CFU vs. 0.9±0.3 CFU) camel milk. However non-significant ($P > 0.05$) variations for the total bacterial counts of the pasteurized and sterilized camel milk were found (Figure 1). Also, El Zubeir (2015) reported that the microbial loads in camel milk were reduced when applying different heat treatments. Suliman *et al.* (2013) mentioned that the purpose of heat treatment of milk include the destruction of microorganism and prolonging its shelf life. Moreover Tay and Chua (2015) reported on the introduction of a pilot pasteurization plant for the raw camel milk; it was based on indirect heating using HTST continuous process (72 °C for 15 seconds) to kill the most harmful microorganisms present in the milk. The slightly reported difference in the microbial loads could be attributed to the different temperature degrees used for pasteurization (78 °C for 15 seconds) and sterilization (137 °C for 4 seconds) of camel milk used during the present study. The high temperature/short time treatment had similar effects to UHT treatment on microbial diversity of camel milk; however, the low temperature/long time treatment had a different impact (He *et al.*, 2020). Also, Yehia *et al.*, 2019) reported that the use of ultra-high temperatures (UHTs) for reducing or killing the bacteria in camel milk is preferable especially where this problem is encountered in camel milk factories.

Significant ($P \leq 0.05$) differences in the bacterial coliform count between the raw and the pasteurized (6.8±2.7 vs. 0.7±0.0 CFU) and between natural and sterilized (2.3±1.5 vs. 0.7±0.0 CFU) camel milk was found (Figure 1).

The relatively low coliform count obtained during the present study (Figure 1) for unheated milk supported the previous data, which showed an acceptable bacteriological quality for camel milk (Warsma and El Zubeir, 2015). However, the high loads obtained for both the total bacteria and the coliform in raw camel milk reported previously (Mohamed and El Zubeir, 2014 and Elhosseny *et al.*, 2018) necessitate the application of pasteurization before the consummation of camel milk. The total bacteria and coliform counts showed highly significant ($P < 0.001$) differences for the raw camel and that were subjected to heat treatment during the storage (Mohamed and El Zubeir, 2014). HTST is an essential milk processing technique that used commonly to destroy the pathogenic microbes in milk products to ensure the production and sale of safe products to the public (Tay and Chua, 2015). Moreover, Warsma and El Zubeir (2015) recommend that heat treatment for camel milk should be encouraged, and that collection centers and, or mobile dairy processing units should be established in the production areas to produce safe, clean camel milk.

Mohamed and El Zubeir (2014) reported that the reasons for the high burden of raw camel milk; when a high microbial load was found; were lack of good practices and sanitation in its treatment, collection, transportation, and storage. Similarly Konuspayeva and Faye (2021) stated that the traditional methods used for camel milk handling and transportation decrease the possibility of marketing the milk to other localities due to the contamination. In a previous study, Mohamed and El Zubeir (2014) found high thermoduric bacterial count in the heat-treated samples of camel milk. The variation might be because in the present study, appropriate pasteurization and sterilization processes were conducted via the use of USPTO UHT+ S1 pilot plant that enables proper heat treatment. The high bacterial counts are expected in milk in Sudan due to the high environmental temperature and lack of cooling (Warsma and El Zubeir, 2015). El Zubeir (2015) reported that the contamination of raw camel milk might be due to the poor hygiene, and environmental contamination, and the milking procedures. she added that the high coliform count could arise from fecal contamination, low level of sanitation, and, or udder infection with mastitis. However, the most dangerous or alarming situation is if people consume pasteurized camel milk contaminated with pathogenic bacteria. Therefore, camel milk should be subjected to high temperatures during its heat treatments in order to kill all kinds of pathogens and other contaminating bacteria associated with raw milk (Yehia *et al.*, 2020).

d) *Comparison of shelf life of pasteurized and sterilized camel milk*

During this study (Tables 2 and 3), both the pasteurized and sterilized camel milk products revealed longer shelf life compared to the original raw milk from which the products were made. Pasteurized camel milk has been successfully undertaken and applied industrially for mass production. Still, ultrahigh temperature (UHT) and sterilization of camel milk resulted in protein instability (Yirda *et al.*, 2020). In a previous reports, Wernery, 2007) and Mohamed and El Zubeir, 2014) found that heating of camel milk resulted in longer shelf life products than the raw original milk. The reason might be because the heat treatment of milk is well known as an efficient method for killing the

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pathogenic and the thermoduric microorganisms. However, Mohamed and El Zubeir (2014) found higher keeping quality (20 days) compared to that found by Wernery (2007) who reported that pasteurized camel milk kept at four °C had a shelf life of 10 days. In this study, the sterilized camel milk showed shorter shelf life in comparison with cow's milk. Ipsen (2017) showed increased viscosity and reduced sedimentation in UHT treated camel milk, and he attributed this to the presence of plasmin during the production of that UHT product. Mohamed and El Zubeir (2014) conducted a study on the heat-treated camel milk, and found that the stability of the total acidity can reach 46 days when storing milk at four °C. After pasteurization, the camel milk can be ready for either consumption or refrigeration storage for further 21 days (Konuspayeva and Faye, 2021). They added that with the introduction of such a pasteurization pilot plant, it is hoped that the level of hygiene and the livelihood of the farmers will be improved as there is a possibility of storing and transporting camel milk safely to satisfy the demands of the consumers.

e) Comparison of sensory evaluation between pasteurized and sterilized camel milk

Non-significant ($P>0.05$) differences were reported for the scores given to the pasteurized and sterilized camel milk for all the studied attributes (appearance, aroma, immediate taste, flavor, taste, after taste, and the overall acceptability) as shown in Figure 2. However, the sterilized camel milk revealed higher scores for all attributes than the pasteurized camel milk (Figure 2).

As shown in Table 4, the panelists recorded non-significant ($P>0.05$) differences for the scores of the preference scales (like very much, like moderately, like slightly, neither like nor dislike, dislike slightly, dislike moderately, and dislike very much) evaluated in each parameter (appearance, aroma, immediate taste, flavor, taste, after taste and acceptance of the overall product) for pasteurized camel milk. However, the scores reported by the panelists revealed significant ($P<0.05$) differences for the preference scales (like very much, like rather, like slightly, neither like nor a dislike, dislike slightly, dislike rather, and dislike very much) evaluated for the aroma and flavor of sterilized camel milk (Table 4). Farah *et al.* (2007) reported that camel milk pasteurization can be achieved at an industrial scale as some dairy plants have good experience in producing such products. Moreover, they added that pasteurized camel milk, with a shelf-life of about a week, can be provided directly to consumers. Furthermore, due to the camel milk's distinct properties, its consumption is going to increase as currently, some industries are promoting the production and processing of camel milk (Ali *et al.*, 2019).

Results in Figure 2 and Table 4, as was recorded by the panelists, it indicated slightly significant ($P\leq0.05$) variations in the scores for aroma and flavor for sterilized milk. However, the scores given by the panelist during the evaluation of the pasteurized and sterilized camel milk products showed non-significant ($P>0.05$) differences in the sensory-evaluated parameters. Moreover, Lund *et al.* (2020) found lower scores for taste, texture, and overall acceptability for camel milk heat-treated samples compared to the control one. Furthermore, in this study, most of the panelists accepted both the pasteurized and sterilized camel milk products (Table 4 and Figure 2). They recorded non-significant ($P>0.05$) differences for the sensory scores between the two products. Lund *et al.* (2020) reported that the highest sensory scores for taste and texture for the camel milk subjected to heat treatment were at 63°C/30 minutes, while the highest keeping quality and the best shelf life of camel milk were obtained at100.5°C/10 minutes.

The salty taste noticed by the panelist (Figure 2 and Table 4) for camel milk is because of the high chloride proportion compared to phosphorous, copper, and iron, as camel feeding is mainly on the dried plants in addition to the shortage of water that available to other dairy ruminants (Khaskheli *et al.*, 2005). Generally, the milk from the camel is white, and its taste is acceptable (El Zubeir and Jabreel, 2008). The global increase in consumption of camel milk is due to its salty taste and medicinal properties (Ali *et al.*, 2019).

IV. Conclusions

This study concluded that pasteurized and sterilized camel milk are rich in their chemical components, which are not different from that of raw milk. In addition, both the pasteurized and sterilized camel milks are safe due to their low bacterial counts and revealed longer shelf life in comparison to the original fresh (unheated) milk. Moreover the acceptability of these products will increase the chance of improving the lifestyles of the camel herders' societies and provides profitable products for the industry in the future.

Acknowledgements

The partial financial support that was received from the Ministry of Higher Education and Scientific Research, Sudan is acknowledged with thanks. The technical assistant provided by the staff of DAL Food's Company (CAPO) during processing and analysis of the camel milk is gratefully acknowledged. The help provided by Dr. Omar A. A. Sidahmed during the statistical analysis of the data is also appreciated with thanks.

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Table 1: Comparison of the physio-chemical properties of fresh and heat-treated milk

Milk constituents	Camel milk (Mean± S.E)			
	Unpasteurized	Pasteurized	Unsterilized	Sterilized
Total solids (%)	$11.18^{a}\pm0.19$	$11.0^{a}\pm0.18$	$11.2^{a}\pm0.11$	$11.0^{a}\pm0.25$
Solids not fat (%)	$7.53^{a}\pm0.12$	$7.5^{a}\pm0.12$	$7.8^{a}\pm0.07$	$7.7^{a}\pm0.16$
Fat (%)	$3.98^{a}\pm0.12$	$3.9^{a}\pm0.092$	$3.7^{a}\pm0.03$	$3.6^{a}\pm0.08$
Free fatty acids (%)	$1.7^{a}\pm0.217$	$1.4^{a}\pm0.098$	$1.2^{b}\pm0.048$	$1.6^{a}\pm0.127$
Lactose (%)	$3.68^{a}\pm0.082$	$3.7^{a}\pm0.072$	$3.9^{a}\pm0.03$	$3.8^{a}\pm0.083$
Protein (%)	$2.43^{a}\pm0.057$	$2.4^{a}\pm0.047$	$2.6^{a}\pm0.047$	$2.5^{a}\pm0.07$
Casein (%)	$1.5^{a}\pm0.05$	$1.5^{a}\pm0.05$	$1.7^{a}\pm0.035$	$1.6^{a}\pm0.07$
Urea (mgL^{-1})	$543.80^{a}\pm22.70$	$570.20^{a}\pm16.65$	$550.3^{a}\pm6.86$	$542.0^{a}\pm15.65$
Citric acid (%)	$0.11^{a}\pm0.011$	$0.11^{a}\pm0.005$	$0.1^{a}\pm0.002$	$0.10^{a}\pm0.006$
Density (gm/cm^{3})	$1.025^{a}\pm0.000$	$1.025^{a}\pm0.000$	$1.026^{a}\pm0.000$	$1.025^{a}\pm0.001$
Acidity (%)	$0.21^{a}\pm0.009$	$0.2^{a}\pm0.007$	$0.1^{b}\pm0.002$	$0.2^{a}\pm0.008$
pH	$6.4^{b}\pm0.024$	$6.5^{a}\pm0.013$	$6.5^{a}\pm0.010$	$6.5^{a}\pm0.006$
Freezing point depression (m°C)	$618.9^{a}\pm18.62$	$466.6^{b}\pm72.81$	$636.9^{a}\pm0.670$	$608.3^{a}\pm24.09$

a, b, c, d Means in the same raw followed by different superscript letters are different (P<0.05) level of probability according to DMRT.

Table 2: Physio-chemical properties of pasteurized camel milk during the storage

Milk constituents	Storage periods/day of camel milk after pasteurization process				
Days	1st	3rd	7th	10th	14th
Total solids (%)	$10.87^{a}\pm0.259$	$11.1^{a}\pm0.080$	$11.01^{a}\pm0.129$	$11.01^{a}\pm0.079$	$10.92^{a}\pm0.292$
Solids not fat (%)	$7.35^{a}\pm0.191$	$7.51^{a}\pm0.021$	$7.50^{a}\pm0.060$	$7.53^{a}\pm0.049$	$7.69^{a}\pm0.122$
Fat (%)	$3.85^{a}\pm0.111$	$3.88^{a}\pm0.073$	$3.81^{a}\pm0.079$	$3.77^{a}\pm0.069$	$3.38^{a}\pm0.045$
Free fatty acids (%)	$1.5^{a}\pm0.164$	$1.8^{a}\pm0.154$	$1.6^{a}\pm0.086$	$1.6^{a}\pm0.088$	$1.7^{a}\pm0.379$
Lactose (%)	$3.62^{a}\pm0.114$	$3.67^{a}\pm0.034$	$3.70^{a}\pm0.030$	$3.73^{a}\pm0.040$	$4.06^{a}\pm0.296$
Protein (%)	$2.42^{a}\pm0.065$	$2.40^{a}\pm0.021$	$2.43^{a}\pm0.024$	$2.45^{a}\pm0.022$	$2.25^{a}\pm0.181$
Casein (%)	$1.5^{a}\pm0.079$	$1.5^{a}\pm0.010$	$1.5^{a}\pm0.028$	$1.5^{a}\pm0.027$	$1.4^{a}\pm0.085$
Urea (mgL^{-1})	$552.8^{a}\pm18.39$	$559.1^{a}\pm5.53$	$554.6^{a}\pm10.32$	$573.3^{a}\pm5.37$	$584.6^{a}\pm13.73$
Citric acid (%)	$0.11^{a}\pm0.006$	$0.10^{a}\pm0.006$	$0.11^{a}\pm0.004$	$0.11^{a}\pm0.003$	$0.12^{a}\pm0.023$
Density (gm/cm^{3})	$1.024^{a}\pm0.001$	$1.025^{a}\pm0.000$	$1.025^{a}\pm0.000$	$1.025^{a}\pm0.000$	$1.026^{a}\pm0.001$
Acidity (%)	$0.20^{a}\pm0.011$	$0.21^{a}\pm0.007$	$0.20^{a}\pm0.004$	$0.20^{a}\pm0.004$	$0.18^{a}\pm0.009$
pH	$6.5^{a}\pm0.013$	$6.5^{a}\pm0.010$	$6.5^{a}\pm0.006$	$6.5^{a}\pm0.016$	$6.5^{a}\pm0.026$
Freezing point depression (m°C)	$592.7^{a}\pm35.82$	$625.9^{a}\pm2.02$	$620.3^{a}\pm9.64$	$600.6^{a}\pm28.79$	$391.1^{b}\pm77.44$

Table 3: Physio-chemical properties of sterilized camel milk during the stooge

Milk constituents	Storage periods/day of camel milk after sterilization process			
Days	1st	3rd	7th	10th
Total solids (%)	$10.9^{a}\pm0.235$	$11.3^{a}\pm0.091$	$10.9^{a}\pm0.509$	$11.3^{a}\pm0.130$
Solids not fat (%)	$7.6^{a}\pm0.152$	$7.7^{a}\pm0.050$	$7.5^{a}\pm0.266$	$7.8^{a}\pm0.093$
Fat (%)	$3.6^{a}\pm0.081$	$3.8^{a}\pm0.066$	$3.6^{a}\pm0.199$	$3.8^{a}\pm0.056$
Free fatty acids (%)	$1.7^{a}\pm0.099$	$1.8^{a}\pm0.101$	$1.7^{a}\pm0.170$	$1.6^{ab}\pm0.233$
Lactose (%)	$3.7^{a}\pm0.077$	$3.8^{a}\pm0.027$	$3.7^{a}\pm0.150$	$3.9^{a}\pm0.034$
Protein (%)	$2.5^{a}\pm0.061$	$2.5^{a}\pm0.033$	$2.5^{a}\pm0.094$	$2.6^{a}\pm0.074$
Casein (%)	$1.6^{a}\pm0.062$	$1.6^{a}\pm0.023$	$1.6^{a}\pm0.086$	$1.6^{a}\pm0.070$
Urea (mgL^{-1})	$532.2^{a}\pm17.29$	$530.8^{a}\pm6.690$	$523.4^{a}\pm40.49$	$541.0^{a}\pm9.073$
Citric acid (%)	$0.1^{a}\pm0.005$	$0.1^{a}\pm0.005$	$0.1^{a}\pm0.010$	$0.1^{a}\pm0.010$
Density (gm/cm^{3})	$1.025^{a}\pm0.001$	$1.026^{a}\pm0.000$	$1.025^{a}\pm0.001$	$1.026^{a}\pm0.000$
Acidity (%)	$0.2^{ab}\pm0.007$	$0.2^{ab}\pm0.004$	$0.21^{a}\pm0.015$	$0.1^{b}\pm0.003$
pH	$6.5^{a}\pm0.006$	$6.5^{a}\pm0.003$	$6.5^{a}\pm0.016$	$6.5^{a}\pm0.011$
Freezing point depression (m°C)	$595.3^{ab}\pm24.80$	$603.2^{ab}\pm25.41$	$473.1^{b}\pm76.58$	$563.7^{ab}\pm67.36$

Mean ± S.E.; a, b, c, d Means in the same raw followed by different superscript letters are different (P<0.05) level of probability according to DMRT.

TS: total solids; SNF: solids not fat; FFA: free fatty acids FPD: freezing point depression.

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Table 4: Comparison between pasteurized and sterilized camel milk regarding sensory evaluation

Score and statistics	Appearance (%)		Aroma (%)		Flavor (%)		Immediate taste (%)		Taste (%)		After taste (%)		Overall product (%)	
	Past.	Ster.	Past.	Ster.	Past.	Ster.	Past.	Ster.	Past.	Ster.	Past.	Ster.	Past.	Ster.
Like very much	10	20	10	5	0	10	0	15	0	15	0	10	5	10
Like moderately	30	30	10	40	25	20	15	20	10	0	5	10	15	20
Like slightly	15	20	30	30	15	45	35	20	25	25	15	25	15	20
Neither like nor dislike	20	25	25	10	20	10	10	20	10	30	25	15	10	15
Dislike slightly	20	5	10	10	25	5	15	5	30	15	20	15	30	15
Dislike moderately	0	0	10	0	5	10	20	10	15	5	25	25	15	10
Dislike very much	5	0	5	5	10	0	5	10	10	10	10	0	5	5
χ^2 value	4.600	3.500	7.300	13.000	4.000	13.000	6.400	3.100	4.600	5.200	4.000	2.800	6.421	2.737
Degree of freedom	5	4	6	5	5	5	5	6	5	5	5	5	6	6
P-value	0.467	0.478	0.294	0.023	0.549	0.023	0.269	0.796	0.467	0.392	0.549	0.731	0.378	0.841
Significant	NS	NS	NS	*	NS	*	NS	NS	NS	NS	NS	NS	NS	NS

Past: pasteurization
Ster: Sterilization

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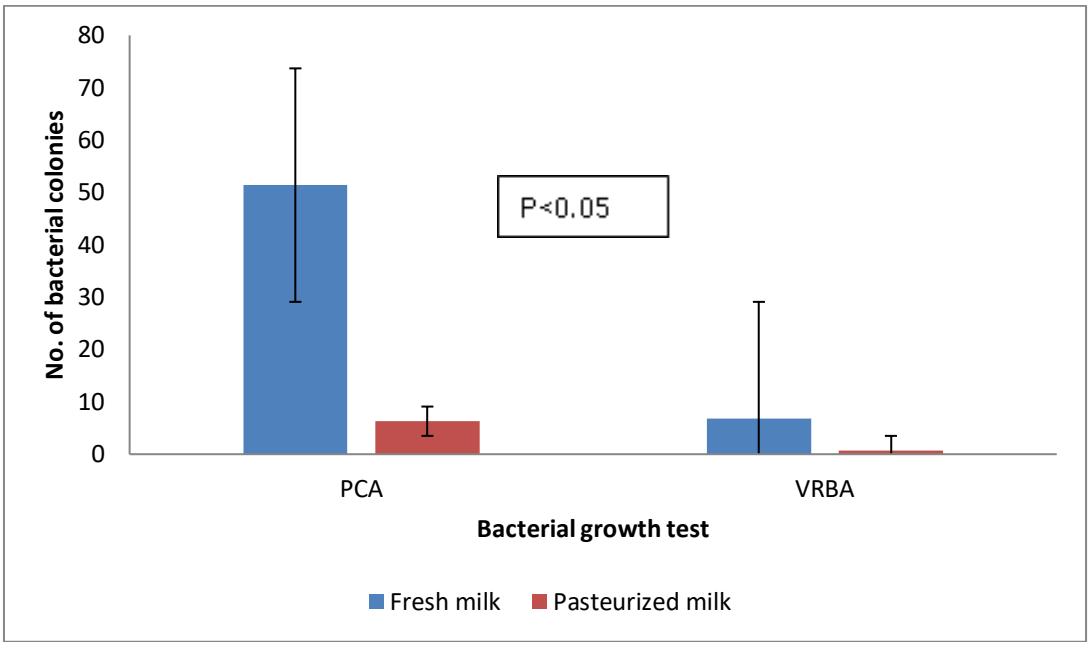

Figure 1a: Comparison of the total bacterial (PCA) and coliform (VRBA) counts of fresh and pasteurized camel milk

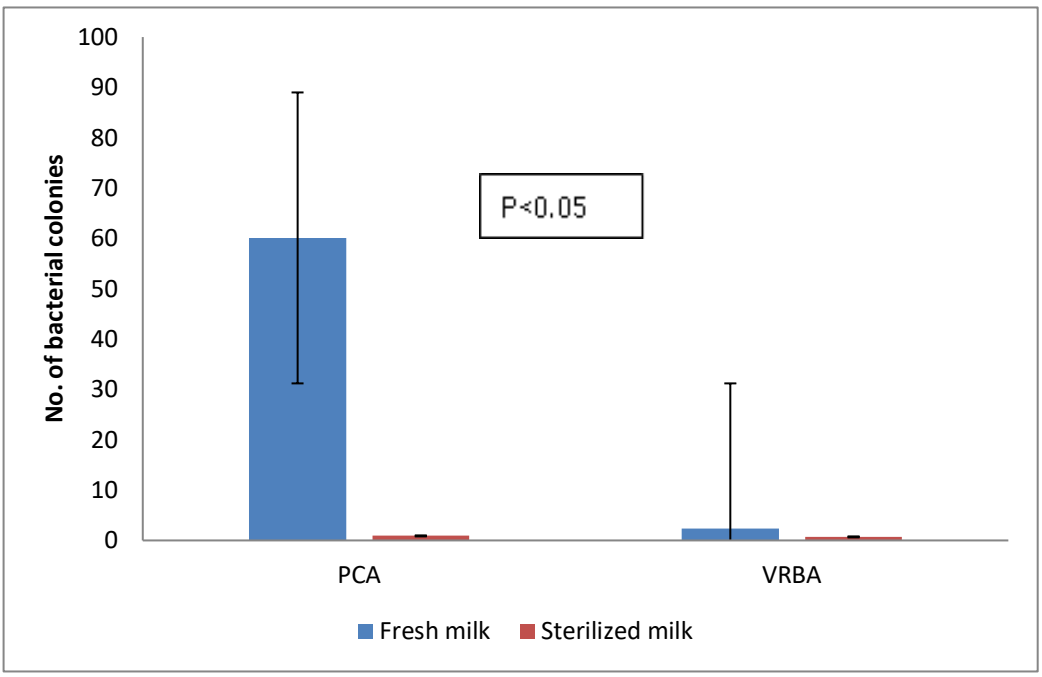

Figure 1b: Comparison of the total bacterial (PCA) and coliform (VRBA) counts of fresh and sterilized camel milk

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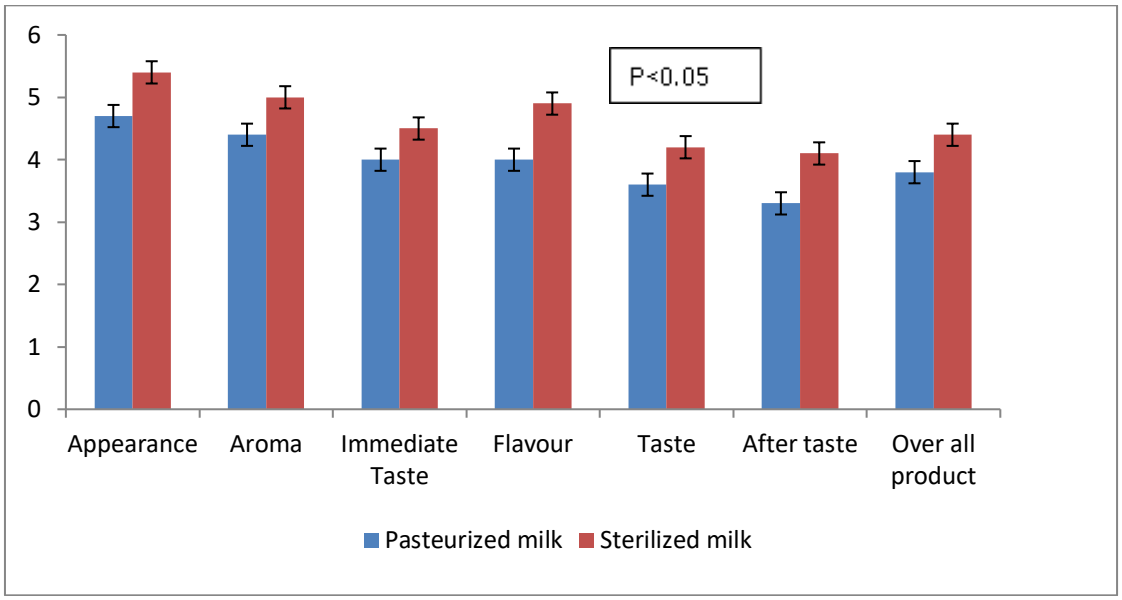

Figure 2: Comparison of the sensory evaluation of pasteurized and sterilized camel milk

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Global Journal of Science Frontier Research: D
Agriculture and Veterinary
Volume 22 Issue 2 Version 1.0 Year 2022
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-460x & Print ISSN: 0975-587X

Selection and Precis(e) Varietal Recommender System

By Rajnish Singh & Shri Niwas Singh
B. R. D. P. G. College

Abstract- A field experiment in a randomized block design was conducted during Rabi season 2019-2020 on 13 wheat varieties with the twin objectives of objectively selecting and precisely recommending the suitable plant types to farmers of Deoria district in eastern Uttar Pradesh. The varieties were evaluated on 12 characters likeplant height (cm), flag leaf area (cm^2), peduncle length (cm), spike length (cm), effective tillers, grains per spike (grain number), grain weight (g), spikelets per spike, test weight (g), grain yield per plant (g), biological yield per plant (g) and harvest index (%). Normalized cumulative ranks were used to objectively select suitable crop ideotypes. The top five varieties *viz.*, HD-2967, MACS-6222, HUW-669, K-0307 and HUW-213 were precisely recommended to farmers of this region for cultivation.

Keywords: *crop ideotypes, normalized cumulative ranks, recommender system, selection.*

GJSFR-D Classification: *DDC Code: 813.4 LCC Code: PS2472*



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Selection and Precis(e) Varietal Recommender System

Rajnish Singh [α] & Shri Niwas Singh [σ]

Abstract- A field experiment in a randomized block design was conducted during Rabi season 2019-2020 on 13 wheat varieties with the twin objectives of objectively selecting and precisely recommending the suitable plant types to farmers of Deoria district in eastern Uttar Pradesh. The varieties were evaluated on 12 characters like plant height (cm), flag leaf area (cm^2), peduncle length (cm), spike length (cm), effective tillers, grains per spike (grain number), grain weight (g), spikelets per spike, test weight (g), grain yield per plant (g), biological yield per plant (g) and harvest index (%). Normalized cumulative ranks were used to objectively select suitable crop ideotypes. The top five varieties *viz.*, HD-2967, MACS-6222, HUW-669, K-0307 and HUW-213 were precisely recommended to farmers of this region for cultivation.

Keywords: crop ideotypes, normalized cumulative ranks, recommender system, selection.

I. Introduction

Wheat is a very staple food crop of billions of people world-wide. However, its production is hampered by non-availability of suitable varieties and local limiting factors. Variety plays an important role and selection of suitable wheat variety is crucial as per local conditions of farmers' fields. That is why an experiment was designed and conducted to evaluate thirteen wheat varieties under the conditions of farmland of B. R. D. P. G. College, Deoria, in eastern Uttar Pradesh, India. The twin objectives of this experiment were to: 1. provide a very objective variety selection procedure and based on this selection, 2. develop a very precise varietal recommender system so that farmers of this region get the best varieties suitable to their field conditions.

II. Materials and Methods

The field experiment under present investigation was conducted during Rabi 2019-2020 at Agricultural Research Farm of Baba Raghav Das Post Graduate College, Deoria in eastern Uttar Pradesh, India. Geographically, this College is located in the eastern part of Uttar Pradesh, India. The site of experiment is located at 26.5°N latitude, 83.79°E longitude and 68 meters (223 feet) above mean sea level. The climate of district is semi-arid with hot summer and cold winter. Nearly 80% of total rainfall is received during monsoon (only up to September) with a few winter- and pre-monsoon showers.

The experimental materials comprised of 13 wheat genotypes available in wheat section of the department of Genetics and Plant Breeding, BRD PG College, Deoria (U.P.). The varieties included are HD-2967, HD-3086, HUW-213, HUW-37, HUW-510, HUW-669, K-0307, MACS-6222, MAYHYCO- GOAL, PBW-343, SHREERAM-303, UP-2672 and WB-2. The experiment was conducted in a randomized block design comprising of thirteen treatments and three replications. The data were recorded on 12 characters including plant height (cm), flag leaf area (cm^2), peduncle length (cm), spike length (cm), effective tillers, grains per spike (grain number), grain weight (g), spikelets per spike, test weight (g), grain yield per plant (g), biological yield per plant (g) and harvest index (%).

III. Data Analysis

The experimental data were collected on 12 parameters of thirteen wheat genotypes. These data were compiled by taking the mean values (Table 1) of five selected plants in each plot and subjected to following non-parametric analysis:

IV. Ranking, Normalizing and Calculating Normalized Cumulative Ranks

An example of a nonparametric statistical analysis procedure is given here to comprehend a small data-set of wheat-diversity for wheat breeding. Thirteen wheat genotypes in three replications were evaluated on twelve parameters. The proposed normalized cumulative ranks considered all the twelve parameters and gave an ordered list of genotypes. Each parameter was given due consideration and a normalized cumulative rank for each genotype was calculated. The cumulative ranks could be normalized in any desired way either by minimum, maximum (directional selection) or mid values (stabilizing selection). In this case the cumulative ranks were normalized by minimum. The parameters needing further attention for the improvement in desired genotypes were identified.

The procedure was carried out in two steps: 1. Calculation of ranks of each genotype and summing the ranks to find cumulative rank, and 2. Normalizing the cumulative ranks by minimum value and finding out a

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preferred list of genotypes by sorting the normalized cumulative ranks. The two steps could be easily understood by the following two formulae: 1. CR $= \sum_{i=1}^{n} R_i$ and 2. NCR = CR/CR$_{min}$, where, CR = cumulative rank; NCR = normalized cumulative rank; R = Rank; n = number of parameters (or characters) evaluated. The values of NCR would range from one to CR/CR$_{min}$. NCR value one (1) would show the best genotype and the maximum value would show the worst genotype. The range would be an indicator of diversity. A single line formula for normalized cumulative ranks (NCR) analysis could be given as $NCR = (\sum_{i=1}^{n} R_i)/(\sum_{i=1}^{n} R_i)min.$

Table 1: Average values based on the three replications

S. NO	GENOTYPES ↓	Plant height (cm)	Flag leaf area (cm2)	Peduncle length (cm)	Spike length / plant (cm)	No. Of productive tillers	Grain no	Grain weight (g)	Spikelets	Test weight (g)	Grain yield (g/plant)	Biological yield (g/plant)	Harvest index (%)
	Sort Order→	0	1	0	0	0	0	0	0	0	0	0	0
1	HD - 2967	92.27	31.11	44.45	12.31	7.2	43.4	2.2	21.67	47.73	11.93	35.33	33.51
2	HD - 3086	91.6	31.27	46.38	9.66	6.8	49.4	2	16.93	36.13	10.07	27.53	37.01
3	HUW - 213	97.57	41.91	50.71	9.86	7.87	59.67	2.13	19.07	38.33	11.33	32.67	34.79
4	HUW - 37	89.41	40.79	45.29	10.47	6.33	44.13	1.73	16.4	40.87	10.6	33.13	32.07
5	HUW - 510	85.75	41.86	46.08	10.33	7.67	43.2	1.87	16.4	42.33	11.27	33.33	34
6	HUW - 669	90.87	38.19	43.81	11.06	6.47	55.73	2.2	19.73	41.13	12.2	32.2	38.42
7	K - 0307	90.99	33.33	46.2	11.26	6.4	52.4	2	19	39.2	12	30.73	39
8	MACS - 6222	90.87	37.45	44.87	10.7	7.4	63.07	2.33	19.67	39.67	12.53	32.4	38.52
9	MAHYCO GOAL	89.29	34.32	45	11.65	5.8	49.07	2	18.87	40.47	9.93	27.53	35.34
10	PBW - 343	82.33	32.18	36.67	9.37	6.4	35.53	1.93	16.6	44.6	8.73	21.4	42.96
11	SHREE RAM - 303	84.49	33.37	42.35	11.39	5.53	46.8	2.07	19.33	42.8	9.07	23.93	39.56
12	UP - 2672	89.85	38.97	45.71	10.4	7.47	45.07	2.27	17.93	43	10.27	31.8	33.63
13	WB - 2	88.11	26.28	39.55	10.07	6.27	57.53	2.27	20.53	38.2	11.53	28.53	39.22

(0 = Descending, 1 = Ascending)

From sort order as given in table 1, it is clear that desirable plant types being selected are for tall plants, less flag leaf area, more peduncle length, and remaining all characters for more.

V. Results and Discussion

The results of the analysis are given in table 2.

Table 2: Ranks, CR and NCR values that give Table 3 on sorting on CR or NCR.

S. NO	GENOTYPES ↓	Plant height (cm)	Flag leaf area (cm2)	Peduncle length (cm)	Spike length / plant (cm)	No. Of productive tillers	Grain no	Grain weight (g)	Spikelets	Test weight (g)	Grain yield (g/plant)	Biological yield (g/plant)	Harvest index (%)	CR	NCR
	Sort Order→	0	1	0	0	0	0	0	0	0	0	0	0		
1	HD - 2967	2	2	9	1	5	11	4	1	1	4	1	12	53	1
2	HD - 3086	3	3	2	12	6	6	8	10	13	10	10	7	90	1.7
3	HUW - 213	1	13	1	11	1	2	6	6	11	6	4	9	71	1.34
4	HUW - 37	8	11	6	7	10	10	13	12	7	8	3	13	108	2.04
5	HUW - 510	11	12	4	9	2	12	12	12	5	7	2	10	98	1.85
6	HUW - 669	5	9	10	5	7	4	4	3	6	2	6	6	67	1.26
7	K - 0307	4	5	3	4	8	5	8	7	10	3	8	4	69	1.3
8	MACS - 6222	5	8	8	6	4	1	1	4	9	1	5	5	57	1.08
9	MAHYCO GOAL	9	7	7	2	12	7	8	8	8	11	10	8	97	1.83
10	PBW - 343	13	4	13	13	8	13	11	11	2	13	13	1	115	2.17
11	SHREE RAM - 303	12	6	11	3	13	8	7	5	4	12	12	2	95	1.79
12	UP - 2672	7	10	5	8	3	9	2	9	3	9	7	11	83	1.57
13	WB - 2	10	1	12	10	11	3	2	2	12	5	9	3	80	1.51

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Table 3: Varietal preference order based on 12 parameters analyzed

S. NO	GENOTYPES ↓	Plant height (cm)	Flag leaf area (cm2)	Peduncle length (cm)	Spike length / plant (cm)	No. Of productive tillers	Grains/ ear	Grain weight (g)	Spikelets	Test weight (g)	Grain yield (g/plant)	Biological yield (g/plant)	Harvest index (%)	CR	NCR
	Sort Order→	0	1	0	0	0	0	0	0	0	0	0	0		
1	HD - 2967	2	2	9	1	5	11	4	1	1	4	1	12	53	1
2	MACS - 6222	5	8	8	6	4	1	1	4	9	1	5	5	57	1.08
3	HUW - 669	5	9	10	5	7	4	4	3	6	2	6	6	67	1.26
4	K - 0307	4	5	3	4	8	5	8	7	10	3	8	4	69	1.3
5	HUW - 213	1	13	1	11	1	2	6	6	11	6	4	9	71	1.34
6	WB - 2	10	1	12	10	11	3	2	2	12	5	9	3	80	1.51
7	UP - 2672	7	10	5	8	3	9	2	9	3	9	7	11	83	1.57
8	HD - 3086	3	3	2	12	6	6	8	10	13	10	10	7	90	1.7
9	SHREE RAM - 303	12	6	11	3	13	8	7	5	4	12	12	2	95	1.79
10	MAHYCO GOAL	9	7	7	2	12	7	8	8	8	11	10	8	97	1.83
11	HUW - 510	11	12	4	9	2	12	12	12	5	7	2	10	98	1.85
12	HUW - 37	8	11	6	7	10	10	13	12	7	8	3	13	108	2.04
13	PBW - 343	13	4	13	13	8	13	11	11	2	13	13	1	115	2.17

Based on the sorted NCR values, as shown in Table 3, the top five varieties *viz.*, HD-2967, MACS-6222, HUW-669, K-0307 and HUW-213 were recommended to farmers of this region for cultivation. In comparison to other varieties, PBW-343 is becoming obsolete and it is evident from table 3 also that its (PBW-343's) ranking is very low in 6 to 8 parameters (1st, 3rd, 4th, 6th, 10th and 11th parameters ranking all 13th and 7th and 8th parameters ranking 11th). Once this variety used to be very popular in this region and long back in a varietal trial (Gaur *et al.*, 2010) its performance was not good compared to other tested varieties. That is why, it was predicted that slowly PBW-343 will become an obsolete variety in this region. The most suitable variety (HD-2967) can be further improved by paying attention to parameters 3rd (peduncle length), 6th (grains/ear) and 12th (harvest index). In this small dataset, PBW-343 ranks first in harvest index. Hence, one may think of crossing PBW - 343 with overall top ranking HD-2967 for its further improvement. This way, if large datasets are created, we could get clues for what needs to be done for further improvement of a newly improved or popular variety. Similarly, grains per ear of HD - 2967could be improved further by crossing with HUW – 213. These ideas might give clues for how to go about gene pyramiding.

a) Precis(e) varietal recommender system

Quite often, due to shortage of time and resources, we have no option but to be very precis(e) in our presentation. This happens during paper presentations, poster presentations and paper writings. This problem comes while presenting the varietal screening data especially when a large number of varieties/ genotypes/ accessions are tried in multi-location trials. Under such a scenario, the raw data (e.g., Table 1) and the ranking data (Table 2) could be combined into a single table as given in Table 4. After sorting the table 4 on CR or NCR, we get Table 5. To be even more precis(e) than the above suggestions, we can give only one table (Table 5) to sum up whole findings. When the numbers of entries in the trials are large enough to present in a single page table, then only a single page could be presented showing only the top performers. This precis(e)ness saves paper, time and money. This experiment and the paper got inspiration from crop ideotype concept of Donald, C.M. (1968). Similar types of non-parametric analyses were carried out by Singh 2017, Singh *et. al.* 2018 and Yadav *et. al*. 2020.

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Table 4: Precis(e) varietal recommendation: combining initial two tables

S. No.	GENOTYPES ↓	Plant height (cm)	Flag leaf area (cm2)	Peduncle length (cm)	Spike length / plant (cm)	No. Of productive tillers	Grain no	Grain weight (g)	Spikelets	Test weight (g)	Grain yield (g/plant)	Biological yield (g/plant)	Harvest index (%)	CR	NCR
	Sort Order→	0	1	0	0	0	0	0	0	0	0	0	0		
1	HD - 2967	92.27 (2)	31.11 (2)	44.45 (9)	12.31 (1)	7.2 (5)	43.4 (11)	2.2 (4)	21.67 (1)	47.73 (1)	11.93 (4)	35.33 (1)	33.51 (12)	53	1
2	HD - 3086	91.6 (3)	31.27 (3)	46.38 (2)	9.66 (12)	6.8 (6)	49.4 (6)	2 (8)	16.93 (10)	36.13 (13)	10.07 (10)	27.53 (10)	37.01 (7)	90	1.7
3	HUW - 213	97.57 (1)	41.91 (13)	50.71 (1)	9.86 (11)	7.87 (1)	59.67 (2)	2.13 (6)	19.07 (6)	38.33 (11)	11.33 (6)	32.67 (4)	34.79 (9)	71	1.34
4	HUW - 37	89.41 (8)	40.79 (11)	45.29 (6)	10.47 (7)	6.33 (10)	44.13 (10)	1.73 (13)	16.4 (12)	40.87 (7)	10.6 (8)	33.13 (3)	32.07 (13)	108	2.04
5	HUW - 510	85.75 (11)	41.86 (12)	46.08 (4)	10.33 (9)	7.67 (2)	43.2 (12)	1.87 (12)	16.4 (12)	42.33 (5)	11.27 (7)	33.33 (2)	34 (10)	98	1.85
6	HUW - 669	90.87 (5)	38.19 (9)	43.81 (10)	11.06 (5)	6.47 (7)	55.73 (4)	2.2 (4)	19.73 (3)	41.13 (6)	12.2 (2)	32.2 (6)	38.42 (6)	67	1.26
7	K - 0307	90.99 (4)	33.33 (5)	46.2 (3)	11.26 (4)	6.4 (8)	52.4 (5)	2 (8)	19 (7)	39.2 (10)	12 (3)	30.73 (8)	39 (4)	69	1.3
8	MACS - 6222	90.87 (5)	37.45 (8)	44.87 (8)	10.7 (6)	7.4 (4)	63.07 (1)	2.33 (1)	19.67 (4)	39.67 (9)	12.53 (1)	32.4 (5)	38.52 (5)	57	1.08
9	MAHYCO GOAL	89.29 (9)	34.32 (7)	45 (7)	11.65 (2)	5.8 (12)	49.07 (7)	2 (8)	18.87 (8)	40.47 (8)	9.93 (11)	27.53 (10)	35.34 (8)	97	1.83
10	PBW - 343	82.33 (13)	32.18 (4)	36.67 (13)	9.37 (13)	6.4 (8)	35.53 (13)	1.93 (11)	16.6 (11)	44.6 (2)	8.73 (13)	21.4 (13)	42.96 (1)	115	2.17
11	SHREE RAM - 303	84.49 (12)	33.37 (6)	42.35 (11)	11.39 (3)	5.53 (13)	46.8 (8)	2.07 (7)	19.33 (5)	42.8 (4)	9.07 (12)	23.93 (12)	39.56 (2)	95	1.79
12	UP - 2672	89.85 (7)	38.97 (10)	45.71 (5)	10.4 (8)	7.47 (3)	45.07 (9)	2.27 (2)	17.93 (9)	43 (3)	10.27 (9)	31.8 (7)	33.63 (11)	83	1.57
13	WB - 2	88.11 (10)	26.28 (1)	39.55 (12)	10.07 (10)	6.27 (11)	57.53 (3)	2.27 (2)	20.53 (2)	38.2 (12)	11.53 (5)	28.53 (9)	39.22 (3)	80	1.51

Table 5: Precis(e) varietal recommendation: sorting on CR or NCR values

S. No.	GENOTYPES ↓	Plant height (cm)	Flag leaf area (cm2)	Peduncle length (cm)	Spike length / plant (cm)	No. Of productive tillers	Grain no	Grain weight (g)	Spikelets	Test weight (g)	Grain yield (g/plant)	Biological yield (g/plant)	Harvest index (%)	CR	NCR
	Sort Order→	0	1	0	0	0	0	0	0	0	0	0	0		
1	HD - 2967	92.27 (2)	31.11 (2)	44.45 (9)	12.31 (1)	7.2 (5)	43.4 (11)	2.2 (4)	21.67 (1)	47.73 (1)	11.93 (4)	35.33 (1)	33.51 (12)	53	1
2	MACS - 6222	90.87 (5)	37.45 (8)	44.87 (8)	10.7 (6)	7.4 (4)	63.07 (1)	2.33 (1)	19.67 (4)	39.67 (9)	12.53 (1)	32.4 (5)	38.52 (5)	57	1.08
3	HUW - 669	90.87 (5)	38.19 (9)	43.81 (10)	11.06 (5)	6.47 (7)	55.73 (4)	2.2 (4)	19.73 (3)	41.13 (6)	12.2 (2)	32.2 (6)	38.42 (6)	67	1.26
4	K - 0307	90.99 (4)	33.33 (5)	46.2 (3)	11.26 (4)	6.4 (8)	52.4 (5)	2 (8)	19 (7)	39.2 (10)	12 (3)	30.73 (8)	39 (4)	69	1.3
5	HUW - 213	97.57 (1)	41.91 (13)	50.71 (1)	9.86 (11)	7.87 (1)	59.67 (2)	2.13 (6)	19.07 (6)	38.33 (11)	11.33 (6)	32.67 (4)	34.79 (9)	71	1.34
6	WB - 2	88.11 (10)	26.28 (1)	39.55 (12)	10.07 (10)	6.27 (11)	57.53 (3)	2.27 (2)	20.53 (2)	38.2 (12)	11.53 (5)	28.53 (9)	39.22 (3)	80	1.51
7	UP - 2672	89.85 (7)	38.97 (10)	45.71 (5)	10.4 (8)	7.47 (3)	45.07 (9)	2.27 (2)	17.93 (9)	43 (3)	10.27 (9)	31.8 (7)	33.63 (11)	83	1.57
8	HD - 3086	91.6 (3)	31.27 (3)	46.38 (2)	9.66 (12)	6.8 (6)	49.4 (6)	2 (8)	16.93 (10)	36.13 (13)	10.07 (10)	27.53 (10)	37.01 (7)	90	1.7
9	SHREE RAM - 303	84.49 (12)	33.37 (6)	42.35 (11)	11.39 (3)	5.53 (13)	46.8 (8)	2.07 (7)	19.33 (5)	42.8 (4)	9.07 (12)	23.93 (12)	39.56 (2)	95	1.79
10	MAHYCO GOAL	89.29 (9)	34.32 (7)	45 (7)	11.65 (2)	5.8 (12)	49.07 (7)	2 (8)	18.87 (8)	40.47 (8)	9.93 (11)	27.53 (10)	35.34 (8)	97	1.83
11	HUW - 510	85.75 (11)	41.86 (12)	46.08 (4)	10.33 (9)	7.67 (2)	43.2 (12)	1.87 (12)	16.4 (12)	42.33 (5)	11.27 (7)	33.33 (2)	34 (10)	98	1.85
12	HUW - 37	89.41 (8)	40.79 (11)	45.29 (6)	10.47 (7)	6.33 (10)	44.13 (10)	1.73 (13)	16.4 (12)	40.87 (7)	10.6 (8)	33.13 (3)	32.07 (13)	108	2.04
13	PBW - 343	82.33 (13)	32.18 (4)	36.67 (13)	9.37 (13)	6.4 (8)	35.53 (13)	1.93 (11)	16.6 (11)	44.6 (2)	8.73 (13)	21.4 (13)	42.96 (1)	115	2.17

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Global Journal of Science Frontier Research: D
Agriculture and Veterinary
Volume 22 Issue 2 Version 1.0 Year 2022
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-460x & Print ISSN: 0975-587X

Smart Agronomy of Wheat Cultivation in Riverbed of Betawa through Natural and Organic Farming under Changing Climate

By R. A. Singh, M. K. Singh, V. B. Jaiswal, Jitendra Singh & I. P. Singh
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Abstract- The present innovative and introductive experiment was laid out during two consecutive rabi seasons of 2009-10 and 2010-11 under "Farmers Participatory Action Research Project on Water/Water Harvesting" (Scheme funded by Central Water Commission, New Delhi). Since, the extensive farming almost closed up because all cultivable land saturated under cultivation of crops and other agricultural enterprises. During the visit of Bundelk hand region of U.P. for scheme work, the riverbed open after water receding of Betawa river was seen. The open riverbed was found suitable for cultivation of winter season crops. Riverbed was suffered from the nodulation of rocks (*Maurang*), but siltation was fertile. Therefore, the site was selected for cultivation of wheat because it has better nutrients status. The riverbed soil was fertilized with organic manure i.e., FYM @ 200 q/ha, vermi cost + vermi-eggs@10 q/ha and mustard cake @ 5 q/ha for major and minor plant nutrients and loosened the riverbed soil. Wheat cv. WH-147 was planted on 15 November and harvested 20 March after 125 days of planting in both experimental seasons.

Keywords: *betawa river, 'gada' rich siltation, river bed soil, water receding, WH-147.*

GJSFR-D Classification: *DDC Code: 813.4 LCC Code: PS2472*



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Smart Agronomy of Wheat Cultivation in Riverbed of Betawa through Natural and Organic Farming under Changing Climate

R. A. Singh [α], M. K. Singh [σ], V. B. Jaiswal [ρ], Jitendra Singh [Ω] & I. P. Singh [¥]

Abstract- The present innovative and introductive experiment was laid out during two consecutive rabi seasons of 2009-10 and 2010-11 under "Farmers Participatory Action Research Project on Water/Water Harvesting" (Scheme funded by Central Water Commission, New Delhi). Since, the extensive farming almost closed up because all cultivable land saturated under cultivation of crops and other agricultural enterprises. During the visit of Bundelk hand region of U.P. for scheme work, the riverbed open after water receding of Betawa river was seen. The open riverbed was found suitable for cultivation of winter season crops. Riverbed was suffered from the nodulation of rocks (*Maurang*), but siltation was fertile. Therefore, the site was selected for cultivation of wheat because it has better nutrients status. The riverbed soil was fertilized with organic manure i.e., FYM @ 200 q/ha, vermi cost + vermi-eggs@10 q/ha and mustard cake @ 5 q/ha for major and minor plant nutrients and loosened the riverbed soil. Wheat cv. WH-147 was planted on 15 November and harvested 20 March after 125 days of planting in both experimental seasons. The wheat sown under conventional system by farmer them self in the vicinity was also selected for the comparison of yield level. The grain yield of wheat grown in riverbed gave 40.10 q/ha, which was 94.68% in comparison to wheat yield of normal soil sown condition (42.35 q/ha). The growth and yield traits were commensurable to the grain yield of wheat.

Keywords: betawa river, 'gada' rich siltation, river bed soil, water receding, WH-147.

I. Introduction

Ravines are networking of gullies. Bundelkhand part of Uttar Pradesh is having 4.92 lakh hectares of ravine lands. Very extensive degradation of land has occurred along with rivers Yamuna, Chambal, Ken, Dhashan, Pahuj, Betawa and their tributaries, which form deep gullies. The 1.29 lakh hectares land available in Hamirpur district of Bundelkhand, which suffer from the ravines, hillocks, valleys etc. These subjected areas are an indication of very bad management of land resources. Erratic, short duration and high intensity rainfall, uneven terrain, faulty agricultural practices, illicitly cutting of tree and over grazing have combined to aggravate the gullies formation in Hamirpur distract of Bundelkhand. Therefore, Hamirpur district of Bundelkhand which is edaphically socially quite different from other districts of Bundelkhand zone of Uttar Pradesh. Characterized by semi arid climate, undulating topography, residual soil of erodible nature, deep water stata underlain with impermeable rocks, poor crop husbandry, including low plant nutrients use and irrigation. During rainy season, the residual nature of soil and rocks reduced infiltration rate and consequently leads to high runoff. The management of this ravine affected area and expansion of wheat cultivation on the basis of conservation production system are the pin points for improving the life style of farm families and their food security. The eroded soil transported through gullies during rainy season and deposited in river bed near to banks. This siltation is most fertile because it contain the various plant nutrients. After receding of river water during winter season, river bed is open. The farming majority use this land for grazing of animals and vegetables cultivation tit-bite. The production of wheat on deposited siltation of riverbed is the subject matter of this manuscript.

II. Materials and Methods

The innovative and introductive field study was laid out during winter season of 2009-10 and 2010-11 at Hamirpur in left riverbed of Betawa river. The study was carried out under "Farmers Participatory Action Research Project on Water/Water Harvesting" (Scheme Funded by Central Water Commission, New Delhi). The pilot soil was silty mixed with fine to coarse granules of rock (Morang). This riverbed siltation (locally called GADA), having pH 7.9, organic carbon 0.29%, total nitrogen 0.02%, available P_2O_5 9.8 kg/ha and available K_2O 167 kg/ha, which indicate the better plant nutrients status. The pH was determined by Electrometric glass electrode method (Piper 1950), while organic carbon was determined by Colorimetric method (Datta *et al*., 1962). Total nitrogen was analyzed by Kjeldahl's method as discussed by Piper (1950). The available phosphorus and potassium were determined by Olsen's method (Olsen *et al*., 1954) and Flame photometric method (Singh, 1971), respectively. The field was fertilized with the application of 200 q/ha FYM. The applied FYM was inoculated with vermi cast and vermi cast eggs @ 10 q/200 q FYM just to prepare the vermi compost *in situ* and increase the demography of earthworm in

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experimental field as suggested by Singh (2006). FYM applied in the experimental field contained 0.50% N, 0.25% P_2O_5 and 0.50% K_2O. Similarly, vermicast and vermicast eggs used as a inoculants was comprised organic matter 16.98%, total nitrogen 1.50%, phosphorus 0.30%, potassium 0.46%, sodium 0.15%, calcium 0.10%, copper 8.5 ppm, iron 7.3 ppm, zinc 10.5 ppm and sulphur 448 ppm (Singh, 2006). The fine powder of mustard cake @ 5 q/ha was also applied with irrigational water at the time of second irrigation. The applications of FYM, vermin cost and vermin cost eggs and mustard cake powder have loosened the siltation soil of riverbed. The applied all organic matter loosened the siltation of riverbed. The applied organic matter was fullfiled all the major and minor plant nutrients specially N-110.88 kg, P_2O_5 51.50 kg and K_2O 96.68 kg/ha. Wheat WH 147 was seeded in rows at the distance of 30 cm using 100 kg seed/ha. The wheat was planted on 15 November and harvested after 125 days on 20 March in both the years. The conservation agronomical practices were followed for raising of wheat crop, planted in riverbed. The protective irrigations were given to crop as and when required with diesel driven pump set. No incidence of insects, pest and diseases was seen in experimental crop.

III. Results and Discussion

The pooled data of two years of grains yield, growth parameters and yield traits of experimental crop recorded and presented in Table-1 and discussed here under appropriate heads.

Since it was innovative and introductive experiment on cv. WH 147 which was grown in the riverbed of Betawa was also compared to the wheat crop grown under normal soil in the vicinity of river bank of Betawa. The collected data of conventional practice sown wheat are also given in Table -1.

1) *Effect on growth and yield traits:* The main shoot height and tillers/plant were found similar to the wheat grown on normal soil with chemical fertilizers. The spike/plant display that wheat grown under two conditions indicated not much difference but normal sown condition wheat showed superiority over riverbed sown wheat. The at par grain weight/plant and 1000-grain weight were observed in both condition sown wheat. The equal uptake of plant nutrients under both the condition by wheat plants was responsible for similar growth and yield contributing characters (Table-1)
2) *Effect on wheat yield (q/ha):* The grain yield of wheat grown in riverbed gave 40.10 q/ha, which was 94.68% in comparison to wheat yield of normal soil sown condition. The yield recorded from normal soil was 42.35 q/ha, which gave only 2.25 q/ha more grain yield in comparison to riverbed wheat grain yield. The residue of chemical fertilizers available in the normal soil was responsible for slightly superior grain yield. The superiority of spike/plant, grain weight/plant and 1000-grain weight were responsible to slightly superior yield of wheat under normal soil conditions.

The riverbed soil have the granules of rocks (Morang), which hinder to the production of tillers/plant, therefore, low tillers production in riverbed soil was responsible for low yield of wheat (q/ha).

The progressive and positive effect of earthworm base organic matter application on wheat yield has also been reported by Singh (1999) and Singh (2006).

IV. Conclusion and Recommendation

Nutrients rich riverbed soil gave wheat yield > 40 g/ha, which is almost similar to the normal soil sown wheat yield, the farming majority residing in vicinity of rivers may be advocated for sowing of wheat in nutrients rich riverbed under extensive cultivation with natural and organic farming.



Figure 1

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Table 1: Growth & yield traits and wheat yield under riverbed and normal soil condition

(Pooled data of two, Years)

S. No.	Treatment	Main shoot height (cm)	Tillers/ plant	Spike/ Plant	Grain weight/ plant (g)	1000-seed weight (g)	Grain yield (q/ha)	Yield (%)
1.	Riverbed sown wheat cv. WH 147	79.30	9.44	6.10	9.60	40.30	40.10	94.68
2.	Normal Soil sown wheat	80.10	9.62	7.00	9.65	40.40	42.35	100.00



Figure 2

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Global Journal of Science Frontier Research (D) Volume XXII Issue II Version I Year 2022
22

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Global Journal of Science Frontier Research: D
Agriculture and Veterinary
Volume 22 Issue 2 Version 1.0 Year 2022
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-460x & Print ISSN: 0975-587X

Investigation of Major Diseases and Pests of Coconut and Areca Palm in Wenchang City

By Wang Yuhang, He Lin, Meng Xiuli, Lin Zhaowei, Song Weiwei, Zheng Jia & Tang Qinghua

Hainan University

Abstract- A systematic investigation was carried out on the diseases and insect pests of coconut and areca palm in Wenchang City of Hain Province from 2019 to 2022. Stem bleeding disease, coconut black-headed caterpillar (CBC), coconut leaf beetle (CLB), and red palm weevil were found to be the main threats to coconut trees; yellow leaf disease (YLD), leaf yellowing virus disease (LYVD), bacterial leaf spot disease, CLB, and Tirathabarufivena (Walker) were observed to be key restricting factors for the areca palm trees. During this survey, 17 species of plants were found as hosts of CBC; YLD and LYVD were observed in five towns including Wencheng and Chongxing; necrotic ringspot virus disease was discovered for the first time in Wencheng and Huiwen. Currently, As the major diseases and insect pests of coconut and areca palm presents a tendency of increasingly serious trend of in Wenchang City, it is recommended that the agriculture and forestry departments to carry out integrated measures, including regular monitoring, forecasting, and timely prevention and control once an outbreak trend is observed, so as to ensure the sustainable and healthy development of the industries.

Keywords: *coconut palm, areca palm, coconut leaf beetle, coconut black-headed caterpillar, yellow leaf disease, leaf yellowing, integrated management.*

GJSFR-D Classification: *DDC Code: 632.7 LCC Code: SB931*



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Investigation of Major Diseases and Pests of Coconut and Areca Palm in Wenchang City

文昌市椰子、槟榔主要病虫害调查

Wang Yuhang [α], He Lin [σ], Meng Xiuli [ρ], Lin Zhaowei [ω], Song Weiwei [¥], Zheng Jia [§] & Tang Qinghua [χ]

王宇航 [α]，何霖 [σ]，孟秀利 [ρ]，林兆威 [ω]，宋薇薇 [¥]，郑佳[§]，唐庆华 [χ]

摘要： 2019－2022 年对文昌市椰子和槟榔病虫害进行了调查，发现危害椰子的主要有泻血病、椰子织蛾、椰心叶甲和红棕象甲；危害槟榔的主要为黄化病、黄叶病毒病、细菌性叶斑病、椰心叶甲、红脉穗螟。本次调查发现椰子织蛾为害的寄主植物有 17 种，在重兴镇、文城镇等 5 镇发现黄化病和黄叶病毒病，在文城镇和会文镇首次发现坏死环斑病毒病。鉴于文昌市椰子和槟榔重要病虫害总体呈逐渐加重趋势，建议农林业部门定期进行监测，做好预测预报工作，一旦发现有爆发趋势及时采取综合防控措施，从而保障产业持续健康发展。

Abstract- **A systematic investigation was carried out on the diseases and insect pests of coconut and areca palm in Wenchang City of Hain Province from 2019 to 2022. Stem bleeding disease, coconut black-headed caterpillar (CBC), coconut leaf beetle (CLB), and red palm weevil were found to be the main threats to coconut trees; yellow leaf disease (YLD), leaf yellowing virus disease (LYVD), bacterial leaf spot disease, CLB, and Tirathaba rufivena (Walker) were observed to be key restricting factors for the areca palm trees. During this survey, 17 species of plants were found as hosts of CBC; YLD and LYVD were observed in five towns including Wencheng and Chongxing; necrotic ringspot virus disease was discovered for the first time in Wencheng and Huiwen. Currently, As the major diseases and insect pests of coconut and areca palm presents a tendency of increasingly serious trend of in Wenchang City, it is recommended that the agriculture and forestry departments to carry out integrated measures, including regular monitoring, forecasting, and timely prevention and control once an outbreak trend is observed, so as to ensure the sustainable and healthy development of the industries.**

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Keywords: coconut palm, areca palm, coconut leaf beetle, coconut black-headed caterpillar, yellow leaf disease, leaf yellowing, integrated management.

I. 引言

文昌市位于海南省东北部，素有“椰子之乡”（Homeland of Coconut）美誉。文昌市现种有椰子树超过 1.33 万 hm^2。椰子树经济寿命长，可达 40～50 年，加之椰果产量、价格较稳定，现已成为当地农民的重要经济来源之一。槟榔是文昌市另外一种重要的经济作物，目前全市种植面积超过 5300 hm^2，在农民增收中也占据着重要的地位。近年来，椰子和槟榔病虫害问题日趋严重，已显著影响到产业的健康发展。

在海南，已报道的严重制约椰子和槟榔产业发展的病虫害非常多，包括椰心叶甲[1-2]、红棕象甲[3]、椰子织蛾[4]、椰子茎干腐烂病[5]、槟榔黄化病[6-7]、槟榔细菌性叶斑病[8]、槟榔黄叶病毒病[9]等。目前，尽管全省范围内的椰子和槟榔病虫害调查较多[10-12]，然而对文昌市病虫害的系统性调查却很少。例如，针对槟榔“癌症”－槟榔黄化病，先前仅车海彦采用 TaqMan-MGC 探针实时荧光 PCR 技术对 2008 年采集于会文镇的样品进行了研究，首次在文昌市检测到病原槟榔黄化植原体[13]。2020 年，Wang 等首次发现槟榔隐症病毒 1（areca palm velarivirus 1，APV1）与海南的部分“槟榔黄化病”相关[9]（由其引起的病害现已更名为槟榔黄叶病毒病[6]）。然而，文昌市槟榔黄化病和黄叶病毒病的分布情况尚不清楚。再如，2014 年唐庆华等报道在昌洒镇首次发现槟榔细菌性叶斑病[8]，该病流行情况直到 2022 年才初步完成[14]。文昌市林业局检疫部门于 2017－2018 年先后对辖区的椰子和槟榔病虫害开展了调查[15-16]，此后鲜有对重要病虫害的系统调查。与此同时，部分病虫害如椰心叶甲和椰子织蛾具有迁飞习性、繁殖能力强[17-18]，极具爆发性，若防治不彻底其种群易于再次反弹甚至爆发。此外，在全球气候变

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暖、产业布局调整等背景条件下，一些先前未发现或发生不严重的病虫害有可能甚至已上升为主要病害（如2018 年报道的槟榔坏死环斑病毒病[19]和 2020 年发现的槟榔黄叶病毒病[9]）。因此，有必要对文昌椰子及槟榔病虫害进行系统调查，摸清现阶段重要病虫害及其发生情况，从而采取相应防控措施。

本调查对于保障文昌市椰子及槟榔产业健康发展具有重要意义，对于文昌市生态健康及美丽乡村建设也具有重要价值。

II. 调查方法

a) 调查时间及地点

2019 年 9 月－2022 年 9 月，先后对文昌市辖区 17 个镇进行了调查。其中，对椰子、槟榔主栽区清澜镇、文教镇、重兴镇、会文镇、文城镇、东郊镇等进行重点调查。

b) 调查对象

椰子织蛾、椰心叶甲、椰子泻血病、红棕象甲、槟榔黄化病、槟榔黄叶病毒病、槟榔细菌性叶斑病、槟榔坏死环斑病毒病、红脉穗螟等。

c) 调查方法

重要病虫害槟榔黄化病、槟榔细菌性叶斑病、椰心叶甲、椰子织蛾等采用五点调查法[17]（方中达，1998）进行调查，记录发病面积并用 GPS 标记发病槟榔园的位置信息。椰子泻血病、红脉穗螟等采样随机踏查法。

d) 病虫害鉴定方法

病害分离鉴定方法：真菌及细菌病害病原分离参考方中达《植病研究方法》[20]并结合形态观察及分子鉴定（真菌采用通用引物 ITS1/ITS4 [22]；细菌采用通用引物 27F/1492R [8]；植原体采用巢式 PCR 引物对组合 F4/R1 和 F2/R2 [23]。病毒病害病原采用分子鉴定的方法，槟榔坏死环斑病毒病采用引物 ANRSV-CPF/ANRSV-CPF [24]；槟榔黄叶病毒病采用引物 4-F/4-R [9]。害虫采用形态观察方法[17-18]。

III. 结果与分析

对文昌市椰子和槟榔病虫害的调查及病原分子鉴定结果显示，危害椰子的主要有椰子织蛾（coconut black-headed caterpillar，*Opisina arenosella* Walker）（图 1-5）、红棕象甲 （red palm weevil，*Rhynchophorus ferrugineus* Fab）（图 6）、椰心叶甲（Coconute Leaf Beetle，*Brontispa longissim* Gestro）（图 7）、椰子泻血病（coconut stem bleeding disease，病原奇异长喙壳菌 *Ceratocystis paradoxa*（Dade） Mor. （无性态为奇异根串珠霉菌 *Thielaviopsis paradoxa*（de Seyn）Hohn.，该病原亦可引起椰子茎干腐烂病）（图 8-9）；危害槟榔的主要为槟榔黄化病（areca palm yellow leaf disease，病原为槟榔黄化植原体 areca palm yellow leaf phytoplasma）和黄叶病毒病（*areca palm necrotic ringspot disease*；病原为槟榔隐症病毒 1，areca palm velarivirus 1）（图 10-12）、椰心叶甲（图 13）、槟榔细菌性叶斑病（areca palm bacterial leaf spot disease，病原为须芒草伯克霍尔德氏菌 *Burkholderia andropogonis*（synonym: *Robbsia andropogonis*）（图 14，病原菌落图 15）、槟榔坏死环斑病毒病（*areca palm necrotic ringspot virus disease*，病原为槟榔坏死环斑病毒 areca palm necrotic ringspot virus）（图 16）、红脉穗螟 *Tirathaba rufivena* （Walker）。此外，椰子次要病害有炭疽病、灰斑病、煤烟病等，槟榔有炭疽病、藻斑病、果腐病、鞘腐病、日灼和冻害等。主要病虫害危害情况见表 1。

a) 椰子病虫害

调查结果显示，文昌市椰子上为害最严重的是椰子织蛾、椰心叶甲、红棕象甲和椰子泻血病。其中，椰子织蛾是一种新发现的危害棕榈科植物的重要入侵性害虫[25]，对我国棕榈科植物的安全生产构成了严重威胁。尽管此前文昌市林业局莫景瑜等对椰子病虫害进行了调查[15]，并对椰子织蛾为害状进行描述，但未对寄主植物进行调查。本次调查发现，该虫于 2019 年在椰子大观园（隶属于中国热带农业科学院椰子研究所）爆发成灾。调查发现该虫可危害椰子（图 1）、蒲葵、圣诞椰子、红柄椰、琼棕、箬棕、酒瓶椰子、斐济榈、华盛顿棕、大王棕（图 2）、糖棕（图 3）、香棕、霸王棕（图 4）、红棕榈、沙巴尔榈、贝叶棕（图 5）、飓风椰子共 17 种棕榈植物。其中，椰子、大王棕、糖棕受害最为严重。2021 年底，该虫在中国热带农业科学院椰子研究所建设管理的棕榈植物种质资源圃再次爆发，造成 30 多株椰子树死亡，并对附近超过 6 hm^2 的棕榈植物造成了严重威胁。此外，调查还发现该虫在文城镇清澜经济开发区以及重兴镇至琼海市长坡镇、长坡镇至文昌市以及文昌市至文教镇的道路沿线等地均有发生，且具有继续扩散趋势。椰心叶甲是海南省一种最重要的可以为害椰子等 10 多种棕榈植物的外来入侵有害生物[26]。本次调查发现文昌市辖区各镇椰树均有受害，但程度不一。椰子泻血病是一种致死性病害[22,27]。2011－2014 年仅椰子大观园每年受害死亡植株超过 30 株（唐庆华等，未发表数据）。根据此前的报道[22]，该病仅限于文城镇。本调查发现该病害在文教镇亦有发生。此外，椰子上红棕象甲、二疣犀甲为害也比较严重。

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b) 槟榔病虫害

本次调查结果表明，为害槟榔最严重的病虫害为槟榔黄化病、槟榔黄叶病毒病、椰心叶甲，细菌性叶斑病为害也较重。其中，槟榔黄化病为一种毁灭性病害，现已给中国[28-29]和印度[30-32]槟榔产业造成了严重损失。槟榔黄叶病毒病是2020年新报道的一种与槟榔黄化相关的病害[9]。本研究发现2种病害主要分布于与流行区琼海市交界的重兴镇、会文镇、文城镇、蓬莱镇。椰心叶甲在各乡镇均有发生，台风过后更容易扩散为害。细菌性叶斑病[8]、坏死环斑病毒病[19]为分别于 2014、2019 年报道的新病害（迄今得到的关注依然并不多），前者于文昌市昌洒镇首次发现，后者于2018年在琼海、定安发现。本次调查发现细菌性叶斑病在会文镇、文城镇、蓬莱镇发生为害，坏死环斑病毒病在文城镇、蓬莱镇亦有发生。此外，部分槟榔园中红脉穗螟为害也较重。

IV. 结论

本次调查结果显示，除了先前报道的主要病虫害椰心叶甲、椰子织蛾、红棕象甲、红脉穗螟、椰子泻血病、槟榔细菌性叶斑病和槟榔黄化病，2018 年之后报道的新病害槟榔黄叶病毒病为害也较重，与槟榔黄化病一起成为槟榔生产中最重要的限制因素。由于近 5 年槟榔价格较高，农户种植积极性非常大，各乡镇均有新种植的槟榔，2 种病害随种苗调运的潜在扩散趋势令人担忧。细菌性叶斑病极易在台风季节爆发、病毒病扩散趋势明显，需要引起注意。槟榔坏死环斑病毒病仅在文城镇和蓬莱镇个别槟榔园中发现，若不加以防范该病害可能会成为今后槟榔生产中需要面对的一种主要病害。对于椰子，2 种外来入侵害虫野心叶甲和椰子织蛾是最重要的 2 种害虫，现已严重威胁着文昌市椰子、槟榔及其他棕榈植物产业。此外，红棕象甲、二疣犀甲、椰子泻血病（以及该病病原引起的椰子茎干腐烂病）也需要进行关注。总之，目前文昌市椰子和槟榔病虫害（尤其是椰心叶甲、椰子织蛾、槟榔黄化病和槟榔黄叶病毒病）发生形势较严重，应得到足够重视。

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V. 防控措施及建议

a) 防控措施

表1：文昌市椰子、槟榔重要病虫害调查及危害情况

病虫害名称	寄主	症状	危害特征	分布
椰子织蛾 coconut black-headed caterpillar	椰子、蒲葵、糖棕、大王棕等 17 种棕榈植物	椰子织蛾以幼虫取食叶片，危害老叶和新叶，并构筑丝网状虫道。受害严重时整个树冠被侵染，叶片干枯脱落，树势衰弱。椰子织蛾还取食苞芽，造成椰树花穗减少、生长迟缓、过早落果等现象，进而严重影响椰果产量。椰子织蛾严重危害椰子后，可造成椰果减产近 50%。	寄主范围广，繁殖快，极具爆发性。发生初期若不能有效控制极易爆发成灾。	重兴镇、文城镇、迈号镇、文教镇等
椰心叶甲 coconut leaf beetle	椰子、槟榔、大王棕等	成虫和幼虫主要潜藏于未展开的心叶或心叶间取食为害。受害心叶伸展后变为枯黄状，严重危害时，新抽叶片呈火烧枯萎状，不久树势衰败以至整株枯死。	椰子上已得控制，槟榔上呈加重趋势。	文昌辖区均有分布
椰子泻血病 coconut stem bleeding disease	椰子，槟榔上也有零星发生	病菌由基部侵入，引起内部组织溃烂，从而整株死亡。泻血病发生时，树干基部裂缝处流出红色汁液，以后逐渐变黑，裂缝组织腐烂，并由基部逐渐向上扩展。严重时冠叶变小，继而树冠凋萎、脱落，重病植株 5～6 年死亡。	冬季低温多雨时易发生，可导致植株死亡。	文城镇、文教镇
红棕象甲 red palm weevil	椰子、霸王棕、大王棕、糖棕等	主要以幼虫钻蛀为害。该虫能为害不同树龄的椰子树，尤其对 3～15 龄椰子树危害较严重。成虫易在植株受伤组织上产卵，尤其是受伤的幼嫩组织，在伤口处分泌大量汁液时容易吸引雌虫来产卵。卵孵化后，幼虫直接取食周围组织，钻蛀为害导致成片椰子林或棕榈科植物死亡。	钻蛀性害虫，隐蔽为害，防控困难。	文城镇
槟榔黄化病 areca palm yellow leaf disease	槟榔	发病初期植株下层 2～3 片复叶的小叶叶尖首先出现黄化，花穗短小，无法正常展开。果实量少且颜色变黑不能食用，常提前脱落。随后黄化症状逐年加重，逐步发展到整株叶片黄化。大部分感病株显症后 5～7 年内枯顶死亡。	槟榔“癌症”，严重威胁产业健康发展。	重兴镇、会文镇、文城镇、蓬莱镇、潭牛镇
槟榔黄叶病毒病 *areca palm leaf yellowing disease*	槟榔	症状类似于槟榔黄化病	严重威胁产业健康发展。	同槟榔黄化病
槟榔细菌性叶斑病 areca palm bacterial leaf spot disease	槟榔	椰苗期和成株期均可染病，主要受害部位为叶片。发病初期在叶片上形成不规则形深绿色至淡褐色水渍状小斑点，密集排列成栅栏状，随后病斑逐渐扩大，形成暗绿色条斑，周围黄晕明显。	台风季节易于爆发。	会文镇、文城镇、蓬莱镇等
槟榔坏死环斑病毒病 *areca palm necrotic ringspot disease*	槟榔	槟榔坏死环斑病毒侵染发病初期叶子病症表现为退绿环斑，后期退绿环斑发展成坏死环斑；槟榔梭斑病毒侵染发病初期叶子病症表现为梭形退绿黄斑，后期梭形退绿黄斑发展成坏死梭斑。	影响光合作用，对产量影响尚不清楚。	文城镇、蓬莱镇
红脉穗螟 *Tirathaba rufivena* (Walker)	椰子、槟榔	幼虫在槟榔未展的花穗上取食，花穗不能正常开放，未能展开的花穗枯死，受害较轻的花穗展开后能开花结果，但果实容易脱落。幼虫一般蛀食果实内的种子和部分内果皮，也会啃食外表皮，造成流胶或形成木栓化硬皮，影响果实品质。钻食叶及生长点，可造成植株死亡。	直接危害花穗和果实，对产量和品质影响大。	文昌辖区均有分布



图1: 椰子织蛾为害椰子



图2: 椰子织蛾为害大王棕



图3: 椰子织蛾为害糖棕



图4: 椰子织蛾为害霸王棕



图5: 椰子织蛾为害贝叶棕



图6: 红棕象甲为害霸王棕



图7: 椰心叶甲为害椰子



图8: 椰子泻血病

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图9: 椰子泻血病



图10: 槟榔黄化病为害



图11: 槟榔黄叶病毒病为害



图12: 椰心叶甲为害槟榔



图13: 槟榔细菌性叶斑病为害

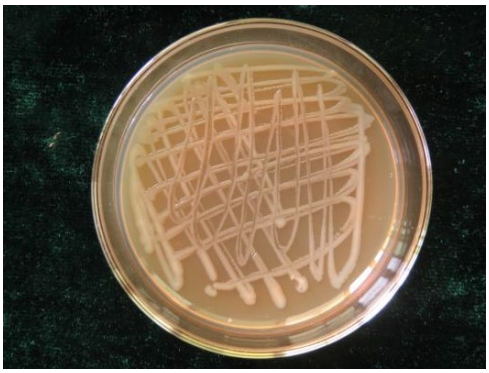

图14: 槟榔细菌性叶斑病菌

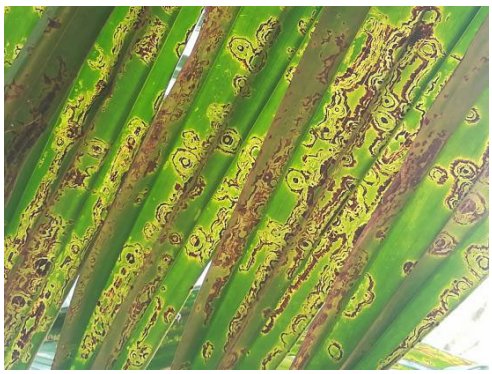

图15: 槟榔坏死环斑病毒病为害



图16: 红脉穗螟为害槟榔花穗

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1. 检疫。对于槟榔黄化病和黄叶病毒病，严禁从疫区调运种苗。
2. 农业防治。加强田间管理，强化水肥管理，提高植株抗性；及时去除受害叶片（如椰子织蛾等），粉碎、喷施农药后深埋或集中销毁。
3. 化学防治。对于椰子织蛾、细菌性叶斑病等喷施高效低毒化学农药如（如啶虫脒、绿乳铜等）进行预防及应急防治。
4. 生物防治。对于椰心叶甲，释放椰甲截脉姬小蜂（*Asecodes hispinarum* Boucek）、椰心叶甲啮小蜂（*Tetrastichus brontispae* Ferriere）进行防治；红脉穗螟也可采用生物防治措施，例如周氏啜小蜂（*Chouioia cunea* Yang）、麦蛾柔茧蜂（*Habrobracon hebetor* Say）和褐带卷蛾茧蜂（*Bracon adoxonphyesi* Mimanikawa）。

b) 建议

本次调查结果显示，椰子织蛾在局部区域爆发且有扩散趋势、椰心叶甲在叶子和槟榔上为害日趋严重、槟榔黄化病和黄叶病毒病随种苗调运扩散的危险性加大。同时，椰子泻血病、槟榔细菌性叶斑病等也具有季节性爆发的特点。为了更好地保障椰子和槟榔产业的健康发展，笔者的建议如下：

1. 文昌市政府高度重视椰子及槟榔病虫害防控工作。
2. 市林业局和农业局等相关部门多与高校和研究所紧密合作，加强病虫害监测、预警以及重要病虫害防控。
3. 加强乡镇农技人员以及农户技术培训，提升病虫害识别及防控能力。

致谢

本文为海南省重点研发项目（ZDYF2022XDNY208）、海南省重大科技项目（ZDKJ201817）、海南省院士创新平台资金（槟榔黄化病综合防控）的阶段性成果之一。在病虫害调查及病原鉴定过程中，研究助理郭春萍和龙仕达参与了部分工作，在此一并表示衷心感谢。

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3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of science frontier then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.



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6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.



Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.



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Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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ISSN 9755896



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