AJPP Asian Journal of
Plant Pathology

OPEN ACCESS

Evaluation of Sodium Metabisulphite Salt (SMBS) as a Fungicide on Common Maize (*Zea mays*) Rust Disease (*Puccinia sorghi*) and its Effect on Wistar Rat Health

[1]Edet, Iwebaffa Amos, [2]Akinbode Oluwafolake Adenike, [3]Onyeanusi Hilary Chukwuemeka and [1]Afolabi, Clement Gboyega

[1]Department of Crop Protection, Federal University of Agriculture, Abeokuta, Nigeria
[2]Institute of Agricultural Research and Training, Obafemi Awolowo University, Ibadan, Nigeria
[3]National Horticultural Research Institute, Idi-Ishin Jericho, Ibadan, Nigeria

ABSTRACT

Background and Objective: Maize, a vital cereal crop globally, faces challenges from foliar diseases like common rust, impacting yield and quality. This study assesses the efficacy of sodium metabisulphite salt (SMBS) in controlling common maize rust caused by *Puccinia sorghi* and its impact on Wistar rat health. It aims to offer insights into SMBS as a sustainable alternative to chemical fungicides by evaluating disease incidence and monitoring rat health post-consumption. **Materials and Methods:** A study at the Institute of Agricultural Research and Training, Obafemi Awolowo University, Ibadan, assessed SMBS for maize disease management and safety. Two maize varieties, ART/98/SW5-OB and T2BR-ELDB, received SMBS treatments (10 and 15 g/L) at different growth stages in a Randomized Complete Block Design with three replications. Disease incidence, severity and agronomic traits were analysed using ANOVA and Duncan's Multiple Range Test at $p<0.05$. **Results:** The results indicated that SMBS application significantly promoted plant growth, as evidenced by increased plant height, leaf number and leaf area with a significant reduction in incidence and severity of common rust disease in maize plants studied, highlighting its potential as a protective agent against fungal infections in crops. However, variations in the responses of different maize varieties to SMBS were observed. The acute toxicity of SMBS was also assessed on Wistar rats as they were exposed to varying doses of SMBS through the consumption of maize leaves and the powdered form. The results demonstrated that SMBS did not cause any significant adverse reactions and death in the rats at the tested doses, indicating a relatively low acute toxicity in this animal model. **Conclusion:** The study confirms SMBS as a promising dual-purpose agent for maize disease control and growth promotion, demonstrating its safety and efficacy, thus advancing sustainable agricultural practices.

KEYWORDS

Sodium metabisulphite, fungicides, Wistar rats, maize varieties, disease, graminae, quality protein maize

ISSN: 1819-1541 (Print)
https://doi.org/10.3923/ajpp.2024.39.48

Received: 03 Jan. 2024
Accepted: 10 Jun. 2024
Published: 11 Jun. 2024

INTRODUCTION

Maize (*Zea mays* L.) is one of the principal cereal food crops in the tropics and subtropics of the world[1]. Maize belongs to the family Graminae (Poaceae). It is the third most important food crop in the world surpassed only by two other grains, wheat and rice[2]. Maize is one of the oldest human-cultivated crops. It grows under a wider range of ecological conditions depending on its variety[3]. The crop is versatile in its use[4], its grain is a rich source of starch or carbohydrate (65-84%), vitamins, (3%) proteins (7-8%) and minerals (10-15%)[5]. The starch derived from its maize kernels is used in confectionery and noodle production. The corn syrup produced from maize rich in fructose is used to make sweeteners. Maize seeds are also used to produce edible oil that is suitable for various culinary purposes chemical fuel derived from maize serves as a non-toxic alternative to petroleum-based ingredients used as antifreeze.

Corn stalks are important in the production of plastics and fabrics. Ethanol produced from maize serves as a renewable biomass fuel. Corn silk, extracted from female corn flowers, serves as a natural herbal supplement. In addition, maize straw serves as an economical energy source, as forage and livestock feed and its stalks can be fermented to produce silage. Presently new breeds have been developed especially The Quality Protein Maize (QPM) and High Protein Maize (HPM) which are nutritionally enhanced maize varieties developed in Agricultural Research and Training (I.A.R and T.) Ibadan in 2009 (I.A.R and T. Compendium 2019), while the HPM has essential amino acids- lysine, tryptophan methionine, etc. to resolve protein deficiency in farmer's households and improve nutritional security in Nigeria. However, the QPM and HPM maize varieties production in Nigeria are plagued by several foliar and stock rot disease[6] the foliar diseases affecting maize, the common rust caused by *Puccinia sorghi* is of worldwide importance[7]. It greatly reduces the grain yield of maize in susceptible genotypes by 40% on average). The reason for this could be attributed to the sweetness and more protein presence in these maize varieties. The fungi disease management often involves indiscriminate use of chemicals or total reliance on host plant resistance (HPR) and Integrated disease management (IDM)[8] chemical fungicides used in controlling fungal diseases are not easily degradable thereby causing bioaccumulation of heavy toxic chemicals to human beings and domestic animals[9]. Hence, many other alternatives of chemical pesticides are explored from other compounds or food preservatives that are healthy and environmentally friendly[9-11].

The first research on the antimicrobial properties of Sodium Metabisulphite Salt (SMBS) a soluble crystalline food preservative powder was conducted on Onion basal rot[12]. Since that time, other research works have been carried out on SMBS against a wide spectrum of microorganisms including viruses, bacteria, fungi, algae and cancer cells[13,14]. It was also reported to stop the growth of silver scurf, dry rot and soft rot in potato[15-19] carried out research on the effect of foliar application of SMBS on pink rot and leaf blight of potatoes in which they suggested that SMBS has potential as an alternative to currently labelled chemical fungicides for controlling crop fungal disease.

Hence, there is a need to carry out studies on Sodium Metabisulphite Salt (E223) (SMBS), which is a synthetic food preservative to control common maize rust caused by *Puccinia sorghi* in the experimental maize farms. Hence, the objective of this study was to evaluate the effect of SMBS on the incidence and severity of common maize rust disease of maize and to determine its post-consumption effect on Wistar rat health after consumption.

MATERIALS AND METHODS

The experiment was carried out from March 2022 (wet season) to November 2022 (dry season) respectively at the Institute of Agricultural Research and Training (I.A.R and T.), Moor Plantation, Ibadan which is located on Latitude 07°23'N, Longitude 03°51'E and Altitude 650 m in the humid zone of the rainforest belt of Southwestern Nigeria with a mean annual rainfall of 1220 mm and mean temperature of 26°C. The rainfall is usually heavy during the wet season (April to September) and scanty in the dry season (November to March). High temperatures and plenty of sunshine generally prevail during the dry season.

While, 2 kg of maize seeds of two varieties (ART/98/SW5-OB and variety 2, T2BR-ELDB) were collected from I.A.R. and T. Germplasm unit. Two seeds per bucket were sown in 155 buckets of 10 L size consisting of humus soil initially heat treated before use after 2 weeks to allow for natural recovery. The maize seeds were sown at two seeds per hole on the already made humus soil buckets which were later thinned to one plant per stand. The experimental plot size was 1.0×1.90 m with 1 m border. The maize seed was sown at 0.25×0.75 m spacing. The maize variety was sprayed with a suspension of maize rust spores after 4 weeks of growth to facilitate the maize rust fungal infection with a control experiment without *Puccinia* spore spray. Weeding was carried out manually at three weeks intervals.

Sodium Metabisulphite (SMBS) salt and 45 Wistar rats were sourced from the Pathology Laboratory, Institute of Agricultural Research and Training (I.A.R and T.), Ibadan, Oyo State Nigeria. The sodium metabisulphite salt (E223) was prepared according to the procedure described by Abdelgawad[20] and Kudi *et al.*[21] with little modification to the process. As 50 g of Sodium Metabisulphite salt (SMBS) (E223) was dissolved in 1000 mL distilled water and 0.5 mL Tween-20 was added to make the preparation stick to the leaves when applied. Maize plants were treated with SMBS at 2, 4, 6 and 8 weeks after planting for use on each day of the experiment and sprayed at 2 week's intervals to control any fungal infections on the fungal sprayed plot while the control plot was never sprayed with SMBS.

The experiment was laid out in Completely Randomized Block Design in three replications.

The treatment was applied by foliar spray method with the aid of a hand sprayer. The SMBS was applied at concentration of 50 g/1.0 L of water. Control plots received no treatment. Data was collected on the disease incidence, disease severity and plant height, number of leaves, leaf area, number of maize cobs and yield. Data were taken at 2, 4, 6 and 8 WAP.

DI = Disease incidence in percentage was calculated using the formula[22]:

$$\text{Disease incidence (\%)} = \frac{\text{Number of infected plants}}{\text{Total number of healthy and infected plants}} \times 100$$

Disease severity was scored using an adopted scale (0-5)[22]

Score	Symptoms
0	No symptoms
1	Very small necrotic lesion on leaves
2	Light necrosis covering less than 40% of the leaf area
3	Moderate necrosis on leaves, 40 to 60% of the leaf area
4	Severe necrosis on 60 to 80% of the leaf area
5	Very severe necrosis on more than 90% of the leaf area or dead plants

The number of leaves was accessed by counting and recording the number of leaves of each tagged plant per plot. The plant height was determined by measuring the plant stand from the soil level to the apex using a meter rule. The leaf area was determined by measuring and multiplying the length and width of the longest leaf of each tagged plant stand per plot with a meter rule. The values of the leaf length and width were multiplied with a constant and recorded.

The stem girth was taken with a vernier calliper by placing the calliper on the stem of the tagged plants and the values obtained were recorded. Days at 50% tasselling were determined by adding the number of days from the planting date to the date at which 50% of the plants on each bed produced tassels. At harvest, the fresh weight of the produce on each plot was weighed with a kitchen scale and the value obtained was recorded. The husk was removed from the maize and the cob weight was recorded according to beds with the aid of a kitchen scale.

Statistical analysis: The data collected were subjected to the Analysis of Variance (ANOVA) procedure of SAS 9.0 to affirm if there was a significant difference among the maize varieties. Means were separated using the Duncan Multiple Range Test (DMRT) at a 5% probability level[23,24].

A preliminary study was done to select 10 Wistar albino rats from the 205 rats collected from the Animal House of the Institute of Agricultural Research and Training (I.A.R and T.), Ibadan, affiliated with Obafemi Awolowo University. Weighing 200-220 g candidates were selected for subsequent toxicity screening. This was done to determine the median lethal dose (LD_{50}) and toxicity level of Sodium Metabisulphite Salt (SMBS) in leaves. Thirty-six albino rats of both sexes were utilized for the study while the rest were left as control experiments. The rats were divided into six groups (A-F) of six animals each. Over 30 days, the groups were administered leaves sprayed with SMBS at varying dosages: Group A: 1000 mg/kg, Group B: 1200 mg/kg, Group C: 1400 mg/kg, Group D: 1600 mg/kg, Group E: 1800 mg/kg and Group F: 2000 mg/kg. The rats were observed for 24 hours daily for 30 days to monitor toxicity symptoms and mortality, with blood samples taken for toxicity analysis.

The LD_{50} was calculated[22] as:

$$LD_{50} = LDy - \Sigma \frac{Dd \times Md}{N}$$

Where:

LDy = Highest dose (LD_{100})
N = Number of animals per group
Dd = Dose difference
Md = Mean dead

The LD_{50} represents the dose that causes 50% mortality in test animals, while LD_{100} signifies the dose causing 100% mortality.

Five pairs of albino rats, weighing between 200-250 g and of both sexes, were fed with maize leaves sprayed with sodium metabisulphite salt (E223) at ascending doses (10, 100, 500, 1000 and 2000 mg/kg b.wt.,) and injected with similar doses. The Wistar rats were housed in appropriately numbered large polypropylene cages with stainless steel top grills, sawdust served as bedding material, replaced twice weekly. The rats had access to pelleted food and clean drinking water. They were acclimatized to laboratory conditions for two weeks prior to the experiment, maintained under a 12 hrs light-dark cycle at 28±2°C. Fed with a standard diet of SMBS-sprayed maize leaves, the rats were observed for toxicity signs and mortality over 24 hrs, both after ingestion of the leaves. Any adverse reactions were documented, including the minimum lethal dose along with any sensitive reactions noted.

RESULTS

Table 1 presents the effect of Sodium Metabisulphite Salt (SMBS) application on the plant height of the two maize varieties (ART/98/SW5-OB and T2BR-ELDB) at 6-8 weeks after planting (WAP). Thus comparing the plant height for the two planting seasons with 10 and 15 g/L SMB treatments, it was observed that there was significant plant height (45.73, 69.40 cm) in the wet season and 150.40, 157.39 cm for dry season on the ART/98/SW5-OB, respectively. When compared to the control experiment without any treatment (20.87, 123.52 cm), respectively. Also, the same observation was seen in T2BR-ELDB SMBS-treated maize with 10 and 15 g/L which recorded significant plant height (69.60, 73.43 cm) in the wet season and 118.3 and 129.50 cm for dry season, respectively with the control experiment (41.77, 47.48 cm) significantly reduced in height at 8 WAP. Thus, for the two seasons studied the treated maize varieties had significant height.

Table 1: Effect of SMBS application on plant height of maize

		Plant height (cm)			
		Wet season		Dry season	
Varieties	Treatments (g/L)	6 WAP	8 WAP	6 WAP	8 WAP
ART/98/SW5-OB	Control	6.13^{bc}	20.87^{bc}	44.93^{a}	123.52^{cd}
	10	27.03^{ab}	45.73^{ab}	60.60^{a}	150.40^{ab}
	15	37.97^{a}	69.40^{a}	67.13^{a}	157.39^{a}
T2BR-ELDB	Control	23.90^{d}	28.83^{d}	41.77^{a}	47.48^{d}
	I0	44.83^{cd}	69.60^{cd}	52.86^{a}	118.37^{cd}
	15	46.20^{bc}	73.43^{abc}	57.67^{a}	129.50^{bc}

Means in the same column with different alphabet are significantly different ($p \leq 0.05$) according to Duncan's Multiple Range Test

Table 2: Effect of SMBS application on number of leaves of maize

		Number of leaves			
		Wet season		Dry season	
Varieties	Treatments (g/L)	6 WAP	8 WAP	6 WAP	8 WAP
ART/98/SW5-OB	Control	5.73^{bc}	6.60^{c}	9.77^{c}	11.87^{bc}
	10	6.27^{abc}	10.27^{ab}	10.77^{ab}	12.80^{ab}
	15	7.23^{ab}	12.00^{a}	11.77^{a}	14.00^{a}
T2BR-ELDB	Control	5.43^{c}	6.40^{c}	10.10^{b}	10.43^{c}
	10	6.53^{abc}	9.27^{bc}	10.63^{ab}	11.50^{bc}
	15	7.80^{a}	9.77^{ab}	11.13^{ab}	12.50^{ab}

Means in the same column with different alphabet are significantly different ($p \leq 0.05$) according to Duncan's Multiple Range Test

Table 3: Effect of SMBS application on leaf area of maize

		Leaf area (mm^2)			
		Wet season		Dry season	
Varieties	Treatments (g/L)	6 WAP	8 WAP	6 WAP	8 WAP
ART/98/SW5-OB	Control	135.33^{c}	469.67^{b}	636.02^{b}	654.20^{c}
	10	243.87^{a}	634.83^{a}	775.48^{a}	1001.10^{a}
	15	165.04^{bc}	795.03^{a}	865.31^{a}	1004.50^{a}
T2BR-ELDB	Control	232.88^{b}	527.18^{b}	610.05^{b}	852.42^{bc}
	10	243.32^{a}	654.54^{a}	785.03^{a}	906.02^{b}
	15	159.36^{bc}	765.91^{a}	847.42^{a}	967.06^{ab}

Means in the same column with different alphabet are significantly different ($p \leq 0.05$) according to Duncan's Multiple Range Test

Table 2 shows that there was a significant difference ($p \leq 0.05$) in the number of leaves in T2BR-ELDB maize treated at 10 and 15 g/L (10.27, 12.00) at 8 WAP for the wet seasons studied. Also, in the dry season higher number of leaves (12.80, 14.00) was recorded when compared to the control (6.60). For the second maize variety the same trend was also observed T2BR-ELDB maize treated at 10 and 15 g/L had significant leaf numbers of 9.27 and 9.77, respectively for the wet season at 8 WAP and the highest number (11.50) (12.50) of leaves was also observed at dry season 8 WAP, respectively. With least number of leaves (10.43) recorded on the control plot. Thus, it can be observed that there was a significant leaves increase on SMBS treated maize varieties.

The effect of SMBS application on leaf area of maize shown in Table 3 indicated that there was a significant increase ($p \leq 0.05$) in the leaf area of the maize varieties treated with SMBS. The maize variety: ART/98/SW5-OB treated with SMBS at a concentration of 10 g/L (634.83, 1001.10) mm^2 and 15 g/L (795.03, 1004.50) mm^2 at 8 WAP. But in the control, experiment reduced leaf area (469.67^{b}, 654.20 mm^2) was recorded also in the T2BR-ELDB maize variety treated with SMBS at a concentration of 10 g/L (654.54, 906.02) mm^2 and 15 g/L (765.91, 967.06) mm^2 at 8 WAP, respectively for the wet and dry season recorded. The control experiment showed a reduced leaf area of (527.18 and 852.42 mm^2) at 8 WAP for the two seasons in the control plot.

Table 4: Effect of SMBS application on incidence of common rust of maize

		Disease incidence (%)			
		Wet season		Dry season	
Varieties	Treatments (g/L)	6 WAP	8 WAP	6 WAP	8 WAP
ART/98/SW5-OB	Control	58.30^{ab}	83.33^{a}	63.12^{b}	85.20^{ab}
	10	16.70^{cd}	40.00^{bc}	33.48^{cd}	31.10^{d}
	15	0.00^{d}	25.00^{d}	35.31^{c}	34.50^{cd}
T2BR-ELDB	Control	66.70^{a}	100.00^{a}	61.05^{b}	82.42^{ab}
	10	33.30^{bc}	38.30^{b}	35.03^{c}	36.02^{c}
	15	16.70^{cd}	33.30^{cd}	31.42^{d}	32.06^{cd}

Means in the same column with different alphabet are significantly different ($p \leq 0.05$) according to Duncan's Multiple Range Test

Table 5: Effect of SMBS application on severity of common rust of maize

		Disease severity (%)			
		Wet season		Dry season	
Varieties	Treatments (g/L)	6 WAP	8 WAP	6 WAP	8 WAP
ART/98/SW5-OB	Control	3.33^{a}	4.33^{a}	3.12^{b}	5.20^{ab}
	10	1.33^{bc}	3.00^{bc}	2.48^{cd}	1.10^{d}
	15	0.00^{d}	2.00^{d}	1.31^{c}	1.50^{cd}
T2BR-ELDB	Control	3.67^{a}	5.00^{a}	3.05^{b}	4.42^{ab}
	10	2.33^{bc}	3.33^{b}	2.03^{c}	2.02^{c}
	15	1.33^{cd}	2.33^{cd}	1.42^{d}	2.06^{cd}

Means in the same column with different alphabet are significantly different ($p \leq 0.05$) according to Duncan's Multiple Range Test

Table 6: Effect of SMBS application on growth per tonnes/Hectares (ton/ha) of maize harvested

		Growth per (ton/ha)	
		Wet season	Dry season
Varieties	Treatments (g/L)	8 WAP	8 WAP
ART/98/SW5-OB	Control	0.21^{bc}	0.25^{c}
Wet season	SMBS-10	0.34^{ac}	0.33^{bc}
Dry season	SMBS-15	0.48^{ab}	0.51^{a}
T2BR-ELDB	Control	0.16^{c}	0.22^{c}
Wet season	SMBS-10	0.33^{bc}	0.32^{bc}
Dry season	SMBS-15	0.37^{ab}	0.42^{ab}

Means in the same column with different alphabet are significantly different ($p \leq 0.05$) according to Duncan's Multiple Range Test

Table 4 showed a significant trend in the effect of SMBS application on the incidence of common rust of maize at 8 WAP. The maize variety ART/98/SW5-OB treated with SMBS at a concentration of 10 g/L had reduced disease incidence of (40.00, 31.00%) and the 15 g/L concentration had (25.00, 34.50%) for the wet and dry season evaluated, respectively at 8 WAP. But the control experiment had significantly higher disease incidence rate of (83.33 and 85.20%) for the wet and dry season recorded. The same trend of higher disease incidence of common rust was also observed in T2BR-ELDB on the control plot (100.00 and 82.42%) with low disease incidence of (38.30 and 36.02%) and (33.30 and 32.06%) for the wet and dry season observed in the T2BR-ELDB variety of maize treated with SMBS at concentrations of 10 and 15 g/L, respectively.

Table 5 showed the effect of SMBS application on the severity of common rust of maize indicating that there were highly significant differences ($p \leq 0.05$) at 6 and 8 WAP for the disease severity recorded as the highest severity (3.33) and (4.33) was recorded in both maize varieties on the control plot. Inversely, the severity of common rust of maize in ART/98/SW5-OB was significantly lower (0.00, 2.00) on the SMBS treated plot at a concentration of 15 g/L at 6 and 8 WAP while in T2BR-ELDB maize variety at 6 and 8 WAP, the highest severity (3.67) and (5.00) was also recorded in the control plot than the treated plot.

Table 7: Determination of LD_{50} of sodium metabisulphite salt (E223) in rats

Dose (mg/kg)	Number of death	Mean death dose difference	Dose difference	Mean death on dose difference
10	0	0.00^a	0.60^a	0.00^a
100	0	0.00^a	90.80^a	0.00^a
500	0	0.00^a	400.00^a	0.00^a
1000	0	0.08^b	990.00^a	0.00^a
1500	0	0.00^a	1490.00^a	0.00^a
2000	0	0.00^a	1990.00^a	0.00^a
Sum (∑)				00.0

Means in the same column with different alphabet are significantly different ($p \leq 0.05$) according to Duncan's Multiple Range Test

Table 8: Toxicity test of the LD_{50} of sodium metabisulphite salt (E223) on the Wistar rats

Group	Number per group	Number of death	Weight (g)	Dose (mL/kg)
A	25	00.10^b	200.63^a	10.01^a
B	25	00.12^b	250.81^a	100.03^a
C	25	00.02^a	300.02^a	500.01^a
D	25	00.16^b	350.13^a	1500.01^a
E	25	00.00^a	400.51^a	2000.02^a
F	25	00.00^a	465.90^a	2500.04^a

Means in the same column with different alphabet are significantly different ($p \leq 0.05$) according to Duncan's Multiple Range Test

Table 6 indicates the yield harvested in ton/ha. The yield was significantly influenced by the application of SMBS as the yield in ART/98/SW5-OB (0.34 and 0.33 ton/ha) was significantly higher when treated with SMBS at a concentration of 15 g/L (0.48 and 0.51 ton/ha). As recorded against yield in untreated plot, with reduced harvest index (0.21 and 0.25 ton/ha) observed for the two seasons, respectively. Also in T2BR-ELDB maize variety, there was also significantly higher harvest with treated SMBS concentrations of 10 g/L (0.33, 0.32 ton/ha) and 15 g/L (0.37, 0.42 ton/ha) as recorded against yield in untreated plot, with reduced harvest index (0.16 and 0.22 ton/ha) observed.

The LD_{50} calculation was performed at different doses ranging from 10 to 2000 mg/kg (Table 7). The determination of LD_{50} (lethal dose 50%) of Sodium Metabisulphite Salt (E223) (SMBS) is observed in the rats by mixing SMBS with the leaves of the maize varieties used as food for the Albino rat was determined using the arithmetic method of Bal and Kumar[25]. The calculated LD_{50} was 2000.0 mg/kg b.wt.

Results of toxicity test of the LD_{50} of sodium metabisulphite salt (E223) on the Wistar rats as described in Table 8:

- **Group A:** No deaths were recorded in this group at a dose of 10.0 mL/kg
- **Group B:** No deaths were recorded in this group at a dose of 100.0 mL/kg
- **Group C, D, E and F:** No deaths were recorded in these groups at doses of 500.0, 1500.0 and 2000.0 mL/kg, respectively

No deaths were recorded at any of the tested doses:

- **Group A:** None of the animals in Group A showed any clinical or behavioural changes throughout the observation period. All animals in Group A were active throughout the study
- **Group B:** In Group B, three of the animals experienced weakness and increased appetite for water. However, they recuperated after 3 hours and no deaths were recorded
- **Group C, D, E and F:** Animals in these groups, which were treated with maize leaves sprayed with Sodium Metabisulphite Salt (SMBS), exhibited weakness and increased appetite for water within the first hour after treatment. The mean death recorded at each dose was 0, indicating that none of the rats died after exposure to the salt. The dose difference and mean death and dose difference were also zero for each dose, suggesting that SMBS salt did not have any toxic effects on the rats at any of the tested doses

DISCUSSION

The experiment was carried out to determine the effect of Sodium Metabisulphite Salt (SMBS) on the incidence and severity of common maize rust disease and also the growth performance of two maize varieties. However, there are few reports on the use of SMBS. The application of SMBS as a fungicide on food crops had been reported to promote plant growth, increase the photosynthetic rate, reduce disease severity and enhance yield by 30%[25,26] reported SMBS had an excellent efficacy in rice (*Oryza sativa* L.) plant and maize (*Zea mays* L.) by reducing the effect of *Curvularia* leaf spot and bacterial leaf blight disease incidence and severity. From this study, it was observed that the same effect was observed as reported by Coca *et al.*[27] and Chen *et al.*[28].

There was a significant increase in the growth parameters measured in the maize variety[29]. Sodium Metabisulphite Salt (SMBS) at concentration levels of 10 and 15 g/L were discovered to have reduced the incidence and severity of common rust of maize, respectively in the two varieties as a result the sodium metabisulphite salt was broken down to release sulfur dioxide, which bounded to carbonyl compounds of an oxidized fat compound in the maize plant to release strong antioxidative action on the fungi pathogen protein layer present in the leaves of the maize varieties. The experiment also showed that maize plants treated with Sodium Metabisulphite Salt (SMBS) at a concentration level of 15 g/L recorded the highest number of leaves, plant height and leaf area. Hence, Sodium Metabisulphite Salt (SMBS) is more effective on (ART/98/SW5-OB) when compared to (T2BR-ELDB). It was recorded that ART/98/SW5-OB had the least disease incidence and severity of maize common rust, the highest plant height, leaf area and number of leaves at 15 g/L when compared to the second variety respectively. This was in tandem with the earlier reports in other plants[30].

The SMBS at concentration level of 15 g/L was discovered to be most effective in the experiment and variety 1(ART/98/SW5-OB) was discovered to have the highest growth parameters translated to yield and least disease incidence and severity.

Furthermore, results of other agronomic traits (Leaf area and number of leaves) that could be translated to growth performance recorded showed that SMBS especially the one with the highest concentration (10 g/L) level had the best performance in disease control also produced the best agronomic trait result recorded. From the laboratory trial, none of the animals in Group A showed any clinical or behavioural changes throughout the observation period. However, weakness and increased appetite for water in the first 1hr were observed in Groups C, D, E and F animals that were treated with the leaves of the maize sprayed with SMBS. All animals in Group A were active throughout the study. In Group B three of the animals suffered weakness and increased appetite for water and they recuperated after 3 hrs and no death was recorded.

The determination of LD_{50} (lethal dose 50%) of sodium metabisulphite salt (E223) in rats. The LD_{50} is a measure of the amount of a substance required to cause the death of 50% of a population that has been exposed to the substance[31,32]. The results showed that no deaths were recorded at any of the tested doses of Sodium Metabisulphite Salt (SMBS). This substantiated that the fed leaves are not toxic to the animals studied as the mean death recorded at each dose was 0, indicating that none of the rats died after exposure to the SMBS salt. The dose difference and mean death were tolerable to the animals used in the experiment. Based on these results, it can be concluded that the LD_{50} of sodium metabisulphite salt (E223) in rats is greater than 2000 mg/kg, which is the highest dose tested in this study. This indicates that the salt did not exhibit acute toxicity in the tested rats at the doses administered during the study. Thus, these findings are essential for assessing the safety of sodium metabisulphite salt and its potential use in agricultural applications as a fungicide[32] without causing any acute toxicity with valuable insights into the effects of Sodium Metabisulphite Salt (SMBS) on maize plants and laboratory rats.

CONCLUSION

The use of Sodium Metabisulphite Salt (SMBS) applied at concentration levels of 10 and 15 g/L greatly enhanced the control of common rust disease of maize caused by *Puccinia sorghi* at 6 and 8 weeks after planting on the two maize varieties. These findings suggest that SMBS may have a role as a plant growth enhancer and disease control agent in agriculture. However, further research is needed to understand the underlying mechanisms responsible for these effects and to determine the optimal application rates and timings for different crops and conditions. In conclusion, while the study provides valuable preliminary data on the effects and safety profile of SMBS, these limitations should be considered when interpreting the findings. Addressing these limitations in future research can lead to a more comprehensive understanding of SMBS's potential benefits and risks in agriculture and other applications.

SIGNIFICANCE STATEMENT

This study investigates Sodium Metabisulphite Salt (SMBS) for its potential in maize disease management and growth enhancement. The SMBS effectively reduces common rust disease and enhances plant growth. Acute toxicity tests on rats consuming SMBS-treated maize indicated low toxicity, ensuring safety for non-target organisms. Future research should explore long-term effects and broader environmental implications. This study advances sustainable agriculture by showcasing SMBS's benefits and emphasizing safety considerations, urging further exploration.

REFERENCES

1. Abebe, F., T. Tefera, S. Mugo, Y. Beyene and S. Vidal, 2009. Resistance of maize varieties to the maize weevil *Sitophilus zeamais* (Motsch.) (Coleoptera: Curculionidae). Afr. J. Biotechnol., 8: 5937-5943.
2. Yang, Q., P. Balint-Kurti and M. Xu, 2017. Quantitative disease resistance: Dissection and adoption in maize. Mol. Plant, 10: 402-413.
3. OECD, 2015. OECD-FAO Agricultural Outlook: 2015-2024. Organization for Economic Cooperation and Development, Paris, France, ISBN: 978-92-64-23190-0, Pages: 145.
4. Khan, I.A., G. Hassan, N. Malik, R. Khan, H. Khan and S.A. Khan, 2016. Effect of herbicides on yield and yield components of hybrid maize (*Zea mays*). Planta Daninha, 34: 729-736.
5. Issa, F.O., J.H. Kagbu and S.A. Abdulkadir, 2016. Analysis of socio-economic factors influencing farmers' adoption of improved maize production practices in Ikara Local Government Area of Kaduna State, Nigeria. Agrosearch, 16: 15-24.
6. Suriani, B. Patandjengi, M. Junaid and A. Muis, 2021. The presence of bacterial stalk rot disease on corn in Indonesia: A review. IOP Conf. Ser.: Earth Environ. Sci. Vol. 911. 10.1088/1755-1315/911/1/012058.
7. Zúñiga-Silvestre, C.A., C. de-León-García-de-Alba, V. Ayala-Escobar and V.A. González-Hernández, 2020. Induced resistance to common rust (*Puccinia sorghi*), in maize (*Zea mays*). Emir. J. Food Agric., 32: 11-18.
8. Mishra, R.S. and V.P. Pandey, 2015. Management of leaf spot of turmeric (*Curcuma longa* L.) caused by *Colletotrichum capsici* through fungicides. J. Spices Arom. Crops, 24: 66-69.
9. Dey, U., S.I. Harlapur, D.N. Dhutraj, A.P. Suryawanshi and R. Bhattacharjee, 2015. Integrated disease management strategy of common rust of maize incited by *Puccinia sorghi* Schw. Afr. J. Microbiol. Res., 9: 1345-1351.
10. Gayathiri, E., P. Prakash, N. Karmegam, S. Varjani, M.K. Awasthi and B. Ravindran, 2022. Biosurfactants: Potential and eco-friendly material for sustainable agriculture and environmental safety-A review. Agronomy, Vol. 12. 10.3390/agronomy12030662.
11. Lengai, G.M.W., J.W. Muthomi and E.R. Mbega, 2020. Phytochemical activity and role of botanical pesticides in pest management for sustainable agricultural crop production. Sci. Afr., Vol. 7. 10.1016/j.sciaf.2019.e00239.
12. Türkkan, M. and I. Erper, 2014. Evaluation of antifungal activity of sodium salts against onion basal rot caused by *Fusarium oxysporum* f.sp. *cepae*. Plant Prot. Sci., 50: 19-25.

13. Blake, D.M., P.C. Maness, Z. Huang, E.J. Wolfrum, J. Huang and W.A. Jacoby, 1999. Application of the photocatalytic chemistry of titanium dioxide to disinfection and the killing of cancer cells. Sep. Purif. Methods, 28: 1-50.
14. Delisle-Houde, M., V. Toussaint, H. Affia and R.J. Tweddell, 2018. Evaluation of different salts for the control of lettuce varnish spot: When phytotoxicity rules. Can. J. Plant Sci., 98: 753-761.
15. Hervieux, V., E.S. Yaganza, J. Arul and R.J. Tweddell, 2002. Effect of organic and inorganic salts on the development of *Helminthosporium solani*, the causal agent of potato silver scurf. Plant Dis., 86: 1014-1018.
16. Mecteau, M.R., J. Arul and R.J. Tweddell, 2002. Effect of organic and inorganic salts on the growth and development of *Fusarium sambucinum*, a causal agent of potato dry rot. Mycol. Res., 106: 688-696.
17. Kolaei, E.A., R.J. Tweddell and T.J. Avis, 2012. Antifungal activity of sulfur-containing salts against the development of carrot cavity spot and potato dry rot. Postharvest Biol. Technol., 63: 55-59.
18. Chauhan, P., M. Singh, A. Sharma, M. Singh, P. Chadha and A. Kaur, 2024. Halotolerant and plant growth-promoting endophytic fungus *Aspergillus terreus* CR7 alleviates salt stress and exhibits genoprotective effect in *Vigna radiata*. Front. Microbiol., Vol. 15. 10.3389/fmicb.2024.1336533.
19. Yaganza, E.S., R.J. Tweddell and J. Arul, 2014. Postharvest application of organic and inorganic salts to control potato (*Solanum tuberosum* L.) storage soft rot: Plant tissue-salt physicochemical interactions. J. Agric. Food Chem., 62: 9223-9231.
20. Abdelgawad, Z.A., 2014. Improving growth and yield of salt-stressed cowpea plants by exogenous application of ascobin. Life Sci. J., 11: 43-51.
21. Kudi, A.C., J.U. Umoh, L.O. Eduvie and J. Gefu, 1999. Screening of some Nigerian medicinal plants for antibacterial activity. J. Ethnopharmacol., 67: 225-228.
22. Wongkham, S., P. Laupattarakasaem, K. Pienthaweechai, P. Areejitranusorn, C. Wongkham and T. Techanitiswad, 2001. Antimicrobial activity of *Streblus asper* leaf extract. Phytother. Res., 15: 119-121.
23. Williams, C.J. and C.M. Moffitt, 2005. Estimation of pathogen prevalence in pooled samples using maximum likelihood methods and open-source software. J. Aquat. Anim. Health, 17: 386-391.
24. Mosaad, R.M., A. Samir and H.M. Ibrahim, 2017. Median lethal dose (LD50) and cytotoxicity of Adriamycin in female albino mice. J. Appl. Pharm. Sci., 7: 77-80.
25. Bal, R.S. and A. Kumar, 2014. Studies on the epidemiology of white rust and *Alternaria* leaf blight and their effect on the yield of Indian mustard. Afr. J. Agric. Res., 9: 302-306.
26. Qudsia, H., M. Akhter, A. Riaz, Z. Haider and A. Mahmood, 2017. Comparative efficacy of different chemical treatments for paddy blast, brown leaf spot and bacterial leaf blight diseases in rice (*Oryza sativa* L.). Appl. Microbiol. Open Access, Vol. 3. 10.4172/2471-9315.1000138.
27. Coca, L.I.R., M.T.G. González, Z.G. Unday, J.J. Hernández, M.M.R. Jáuregui and Y.F. Cancio, 2023. Effects of sodium salinity on rice (*Oryza sativa* L.) cultivation: A review. Sustainability, Vol. 15. 10.3390/su15031804.
28. Chen, Y., J.H. Jin, Q.S. Jiang, C.L. Yu, J. Chen, L.G. Xu and D.A. Jiang, 2014. Sodium bisulfite enhances photosynthesis in rice by inducing *Rubisco activase* gene expression. Photosynthetica, 52: 475-478.
29. Li, Z., Y. Wu, D. Xing, K. Zhang and J. Xie *et al*., 2021. Effects of foliage spraying with sodium bisulfite on the photosynthesis of *Orychophragmus violaceus*. Horticulturae, Vol. 7. 10.3390/horticulturae7060137.
30. Akhila, J.S. D. Shyamjith and M.C. Alwar, 2007. Acute toxicity studies and determination of median lethal dose. Curr. Sci., 93: 917-920.
31. Chao, A., R.L. Chazdon, R.K. Colwell and T.J. Shen, 2005. A new statistical approach for assessing compositional similarity based on incidence and abundance data. Ecol. Lett., 8: 148-159.
32. Sangeetha, J., A. Mundaragi, D. Thangadurai, S.S. Maxim, R.M. Pandhari and J.M. Alabhai, 2019. Nanobiotechnology for Agricultural Productivity, Food Security and Environmental Sustainability. In: Nanotechnology for Agriculture: Crop Production & Protection, Panpatte, D.G. and Y.K. Jhala (Eds.), Springer, Singapore, ISBN: 978-981-32-9374-8, pp: 1-23.