Antimicrobial Activities of Extracts and Flavonoid Glycosides of Corn Silk (*Zea mays* L)

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Abstract: Corn silk refers to the stigmas of *Zea mays* L. (*Gramineae*) from the female flowers of maize. Based on its flavonoid contents, it is medicinally used in the treatment of a number of diseases. Screening of plants against pathogenic bacteria is an important step to validate its medicinal properties. Therefore, the aim of this study was to investigate the antimicrobial activities of different solvent extracts, flavonoids of corn silk and compare the activities with standard antibiotic gentamycin. The petroleum ether (PECS), chloroform (CECS) and methanol (MECS) extracts (25 mg/mL) of corn silk were tested for their antimicrobial activity. Twelve pathogenic bacteria: *Bacillus cereus, Bacillus subtilis, Staphylococcus aureus, Pseudomonas aeruginosa, Enterobacter aerogenes, Salmonella typhi, Salmonella paratyphi, Escherichia coli, Shigella sonnei, Shigella flexneri, Proteus vulgaris, Proteus mirabilis* and one yeast *Candida albicans* were used to investigate the antimicrobial activities of the extracts. Gentamycin (50 μg/mL) was used as reference antibiotic. Two isolated flavonoid glycosides (2.0 mg/mL) of corn silk were tested for their antimicrobial activity. The microbial growth inhibitory potential was determined by using the agar hole-plate diffusion method. PECS, MECS and flavonoids were active against eleven bacteria out of twelve bacteria. CECS was active only against five bacteria. No extracts and flavonoids were sensitive against *Escherichia coli* and *Candid albicans*. The results were compared with gentamycin, which was active against all the bacteria tested. Extracts and flavonoids showed significantly ($p<0.05$) higher sensitivity against a number of bacteria than gentamycin.

Keywords: *Zea Mays*, Corn silk, Plant extract, Flavonoid glycosides, Antimicrobial activity.

1. INTRODUCTION

Corn silk ascribed as stigmata of maize female flowers of *Zea mays* L. (*Gramineae*), are fine soft thread 10-20 cm long, commonly cultivated in warm climates. It is medicinally used as a mild stimulant, diuretic and demulcent, useful in acute and chronic cystitis and in the bladder irritation of uric acid and phosphatic gravel; has also been employed in Gonorrhoea [1]. In Chinese medicine, corn silk is used for oedema of various origin and for hepato-biliary disease [2]. The medicinal properties of corn silk supported by several authors as it exhibited antioxidant activity [3-6], anti-diabetic activity [7, 8], antibiotic activity towards corn earworm [9], resistance to insect attacks [10] and antitumour activity [11]. Phytochemical studies on corn silk revealed that it contained a number of flavonoids, chlorogenic acid, p-coumaric, ferulic acid, saponins, phytosterols, volatile oil, fixed oil, resin, sugars, allantoin, tannin and minerals [12-16]. Since one of the standard approaches for determining potential medicinal use of plants and their chemical constituents is to screen them for activity against a wide range of viruses, bacteria and pathogenic fungi, therefore, the present work was undertaken to further the study on the medicinal herb, corn silk, found in Malaysia, and to establish fairly comprehensive data on its chemical constituents and their antimicrobial properties. In this investigation, phytochemical analysis on corn silk resultant the isolation of two flavonoid glycosides, therefore, the objectives of this study was to investigate the antimicrobial activities of different solvent extracts of corn silk and its flavonoid glycosides, and to compare the activities with standard antibiotic gentamycin.

2. MATERIALS AND METHODS

2.1. General Experimental Methods

Melting points were determined on a Gallenkamp instrument and are uncorrected. FTIR spectra were recorded on a Bomem Hartmann and Braun, MB-Series instrument; UV spectra were recorded on a Hitachi U-2000 spectrophotometer. ESI MS spectra were obtained from a Finnigan LC-Q Classic, Ion Trap Spectrometer. ^{1}H and ^{13}C NMR spectra were acquired using Bruker Avance 300 MHz spectrometers equipped with 5 mm bore gradient-pulse inverse probeheads. Samples were dissolved in DMSO-d_6 and chemical shifts were recorded in δ (ppm) relative to that of TMS (δ= 0.00 ppm).

2.2. Plant Materials

Freshly collected corn silks (Speicimen voucher No. 8765 for the *Zea mays,* The School of Biology,

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Universiti Sains Malaysia), were oven dried (40°C) for 5 days, and then milled into powder. The powdered silks (300 g) were then extracted first with petroleum ether (60-80°), followed by chloroform and then finally with methanol (2.5 liters each) in a Soxhlet extractor for 30 hours each. After removal of the solvents by vacuum evaporation the percent of yield for pet-ether (PECS), chloroform (CECS) and methanol (MECS) extracts was about 1.1 %, 1.2 % and 6.5 %, respectively. All the samples were freeze dried by using the Cole-Parmer benchtop freeze dryer (Model LD-53, Kingston, NY) before testing for antimicrobial studies.

2.3. Isolation of Flavonoid Glycosides from Methanol Extract

The methanol extract (18 g) was stirred with 500 mL of water and the contents were extracted with n-butanol (3 x 300 mL). Dried butanol extract (3 g) was subjected to column chromatography over Sephadex-LH-20 with methanol as eluent. Fractions of 20 mL were collected. Fractions 5-10 (120 mL), was evaporated to a yellow glass like solid mass, was recrystallized from methanol to give compound **I** (12 mg). It showed one yellow-orange spot at R_f 0.277 on silica gel plate [n-butanol:acetic acid:water (BAW), 5:1:4, upper phase] with NP-reagent. Fractions 21-25, was evaporated to give compound **II** (14 mg), was recrytallized from methanol to yellow powder. It showed one spot at R_f 0.295 on silica gel plate (BAW, 5:1:4) with NP-reagent. Hydrolysis of **I** and **II** (1 mg each, separately) was heated with 2N HCl (5 mL) for 3 hours at 100°C and extracted with ethylacetate (3 x 10 mL). The organic extract was washed with water and evaporated. The aglycone obtained gave one spot. The aqueous portion left was dried under high vacuum and the sugar residue was chromatographed on TLC (BAW, 4:1:5, upper phase) and identified as rhamnose (R_f 4.3) by comparing with authentic sugar.

2.4. Spectral Data

Compound (**I**): M.p. 222-224 °C (decompose). $FeCl_3$ test: (+); UV max (MeOH): 349, 270 (sh), 256 (sh), 212; NaOMe 406, 264, 212; $AlCl_3$ 422, 276, 211; $AlCl_3$/HCl 379, 278, 211; NaOAc 413, 270, 228; NaOAc/H_3BO_3 374, 263, 222 nm; IR bands (KBr disc): 3397, 1730, 1659, 1620, 1343, 1098, 809 cm^{-1}; ESI-MS *m/z* (%): M^+ +1, 577 (100). ^1H NMR (300 MHz, DMSO) and ^{13}C NMR (75 MHz, DMSO) spectral data are presented in Table **1**.

Compound (**II**): M.p. 193-195 °C. $FeCl_3$ test: (+); UV max (MeOH): 347, 270, 242 (sh), 211; NaOMe 412, 336 (sh), 280(sh), 259, 212; $AlCl_3$ 389, 365, 297 (sh), 279, 262 (sh), 235 (sh), 211; $AlCl_3$/HCl 387, 361, 298 (sh), 279, 260 (sh), 235 (sh), 211; NaOAc 407, 279, 221; NaOAc/H_3BO_3 349, 270, 222 nm; IR bands (KBr disc): 3444, 1726, 1642, 1623, 1346, 1198, 1088, 831 cm^{-1}; ESI-MS *m/z* (%): M^+ +1, 591 (100), 445 (46) and 315 (25). ^1H NMR (300 MHz, DMSO) and ^{13}C NMR (75 MHz, DMSO) spectral data are presented in Table **1**.

2.5. Antimicrobial Screening

The microorganisms used in this study included four gram-positive bacteria e.g. *B. cereus, B. subtilis, Staph. aureus, P. aeruginosa* and eight gram-negative bacteria e.g. *Ent. aerogenes, S. typhi, S. paratyphi, E. coli, S. sonnei, S. flexneri, Prot. vulgaris, Prot. mirabilis* and one yeast e.g. *C. albicans*, were obtained from the stock culture of the Microbiology Laboratory of the School of Pharmaceutical Sciences, Universiti Sains Malaysia, Penang, Malaysia. Bacterial strains were grown on nutrient agar and yeast strains in sabouroud dextrose agar suspended in nutrient broth. Subculturing was done once weekly.

The microbial growth inhibitory potential of the extracts was determined by using the agar hole-plate diffusion method [17]. For preparation of inocula, few colonies were mixed with sterile 0.8% nutrient broth solution and compared the turbidity with that of standard 0.5 McFarland solutions, which was equivalent to 10^6-10^8 CFU/ml. The inoculum was added to molten agar and the media was thoroughly shaken to disperse the microorganisms. Different organic solvent extracts of corn silk (25 mg/ml) and the isolated compound (2.0 mg/ml) were prepared in 10% DMSO [17]. Holes (7 mm diameter) were made in the solidified media by punching with a sterile cork borer, then 70 μL of the plant extract solution was introduced in each hole. For positive control, 70 μL of standard antibiotic gentamycin solution (50 μg/ml) was introduced into the wells. A blank was also run, consisting of holes with 70 μL of the solvent only (10% DMSO). This was done to check for sterility and any growth inhibitory potential of the solvent. All plates were left at room temperature for 2 hr to allow the diffusion process to take place. Then the plates were incubated at 25 °C for 3 days for fungus and at 37 °C for 24 hr for the bacteria. All determinations were performed in triplicate. Zones of inhibition were measured after the incubation period from the edge of each well. All the results are expressed as mean ± standard deviation (S.D.). The data were subjected to a one-way analysis of variance (ANOVA) and Tukey's test ($p<0.05$) was performed to

Table 1: Summary of Spectral Data of ^{1}H-NMR and ^{13}C-NMR of Flavonoid Glycosides (I and II) of Corn Silk

Position	Maysin (I)		Maysin-3′-methyl ether (II)	
	^{1}H NMR δ (DMSO- d_6) ppm	^{13}C δ (DMSO- d_6) ppm	^{1}H NMR δ (DMSO- d_6) ppm	^{13}C δ (DMSO- d_6) ppm
C2	-	164.53	-	164.30
C3	6.70 (1H, s)	103.53	6.92 (1H, s)	104.40
C4	-	182.93	-	183.10
C5	13.81 (1H, s, -OH)	162.07	13.81 (1H, s, -OH)	162.10
C6	-	108.37	-	108.30
C7	-	163.06	-	164.20
C8	6.49 (1H, s)	93.86	6.54 (1H, s)	94.00
C9	-	157.33	-	157.30
C10	-	103.76	-	103.80
C1′	-	122.13	-	122.10
C2′	7.42 (2H, overlapped)	114.15	7.57 (2H, overlapped)	110.90
C3′	-	146.62	-	148.92
C4′	-	150.62	-	151.60
C5′	6.89 (1H, d, J = 8.14 Hz)	116.94	6.93 (1H, d, J = 8.2 Hz)	116.60
C6′	7.42 (2H, overlapped)	119.86	7.57 (2H, overlapped)	121.2
C1″	5.30 (1H, d, J = 10 Hz)	72.03	5.30 (1H, d, J = 10 Hz)	72.0
C2″	4.83 (1H, d, J = 10 Hz)	78.90	4.83 (1H, d, J = 10 Hz)	78.40
C3″	4.40 (1H, br)	78.96	4.46 (1H, br)	78.90
C4″	-	206.90	-	206.90
C5″	3.9 (1H, br)	76.26	4.17, (1H, br q, J = 5.1 Hz)	76.20
C6″ (-CH_3)	1.29 (3H, d, J = 6 Hz)	18.16	1.30 (3H, d, J = 6 Hz)	18.17
C1‴	5.24 (1H, d, J = 10 Hz)	100.09	5.24 (1H, d, J = 10 Hz)	100.0
C2‴	3.77 (1H, s)	70.99	3.70 (1H, s)	71.0
C3‴	3.0 (2H, complex)	70.99	3.0 – 3.5 (2H, complex)	71.0
C4‴	3.0 (2H, complex)	74.14	3.0 – 3.5 (2H, complex)	74.10
C5‴	2.4 (1H, complex)	69.70	2.4 (1H, complex)	69.70
C6‴ (-CH_3)	0.67 (3H, d, J = 5.9 Hz)	19.83	0.66 (3H, d, J = 5.8 Hz)	19.80
3′-OCH_3	-	-	3.99 (3H, s)	56.80

determine the significance of the difference between means.

3. RESULTS AND DISCUSSION

3.1. Structure Determination of Isolated Compounds

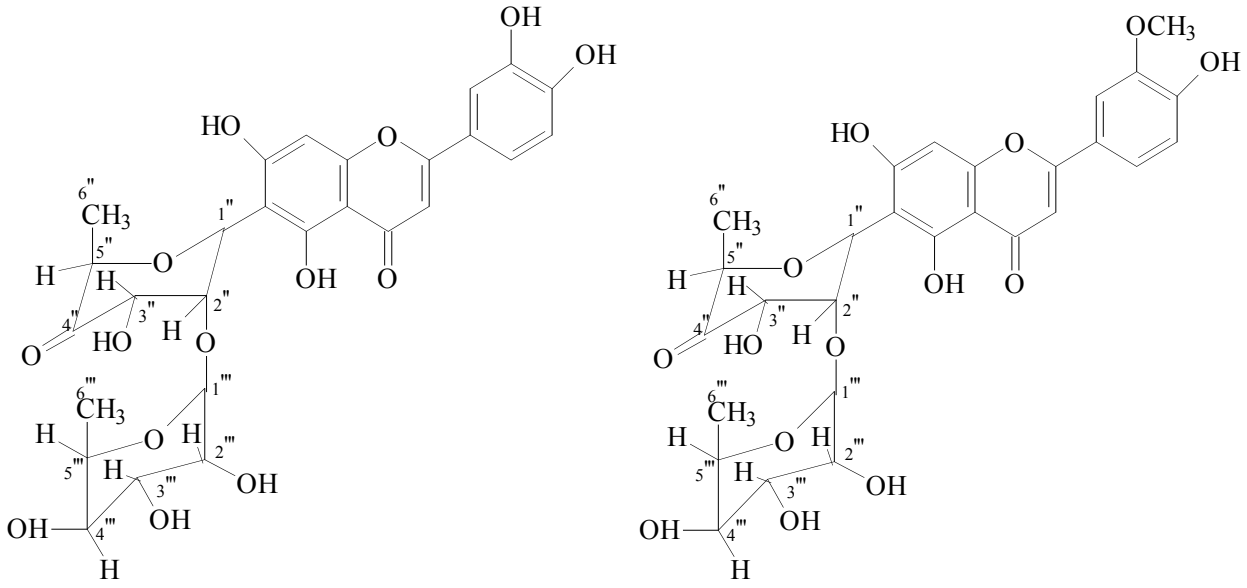
Compound **(I)** is a yellow powder, decomposed at 222-224 °C. Its molecular formula $C_{27}H_{28}O_{14}$ was confirmed by ESI-MS positive ions spectrum (577). Its UV spectral data exhibited characteristics for flavone nucleus. The bathochromic shift of band I (57 nm) with aluminum chloride and hypsochromic shift of band I (43 nm) with addition of hydrochloric acid but bathochromic shift (30 nm) relative to methanol indicated the presence of 5-OH with ortho-dihydroxyl group in its B ring. It was supported by the formation of boric acid complex [18]. The bathochromic shift of band I (57 nm) with increased intensity on addition of sodium

methoxide indicated the presence of free hydroxyl group at C-4′ position. The presence of free hydroxyl group confirmed from its bathochromic shift of band II (14 nm) with sodium acetate. Its ^{1}H NMR spectrum was assigned with the literature reported by Elliger *et al*. [12]. The signal at δ 6.70 (1H, s) was assigned for H-3, was a characteristic for flavone. The A ring protons appeared at δ 6.49 (1H, s) accounted for H-8, suggested the substitution at C-6 position. Its B ring protons appeared at δ 6.89 (1H, d, J = 8.14) and δ 7.42 (as overlapped signal integrating for two protons) were accounted for H-5′ and H-2′/H-6′ respectively. Hydrolysis of I with 2N HCl (100°C, 3 hr), yielded the sugar rhamnose, was identified by comparing with authentic sugar using thin-layer chromatography, which indicated that it was a terminal sugar. The characteristic signal at δ 0.67 (3H, d, J = 5.9 Hz) for the methyl group of rhamnose, once again confirmed the presence of this sugar. The resistance to hydrolysis of the remaining aglycone revealed the presence of other sugar, which might attach at C-6 as the deoxyhexosulose. It was consistent with observation of a non-flavonoid IR band for C=O at 1726 cm^{-1} as well as the ^{13}C NMR signal appearing at 206.9 ppm which indicated the presence of an aliphatic ketone. The other signal for sugar moieties was confirmed from the reported data for this compound [12]. The ^{13}C NMR spectral data (Table **1**) was also consistent with Snook *et al*. [13]. Based on the above data, the compound **I** was identified as 2′′-O-α-L-rhamnosyl-6-C-(6-deoxy-xylo-hexos-4-ulosyl)-luteolin or namely maysin (**I**).

Compound **(II**) a yellow powder, m.p. 193-195 °C. It's molecular formula $C_{28}H_{30}O_{14}$ was confirmed by ESI-MS positive spectrum (M^++H, 591). Its IR spectrum showed strong absorption band at 1726 cm^{-1} indicated the presence of an aliphatic ketone (C=O). Its UV spectrum changes with various additives showed typical flavonoid absorption and gave characteristics shift for the basic luteolin structure. A bathochromic shift of band I of 65 nm with increase of intensity with sodium methoxide and band II of 9 nm with sodium acetate were observed, suggesting the presence of a free hydroxyl group at C-4′ and C-7 positions. The UV spectrum exhibited a bathochromic shift of band I of 42 nm with aluminum chloride and no change of absorption band in presence of hydrochloric acid indicated the absence of orthodihydroxyl groups in its B-ring and presence of a chelated hydroxyl group at C-5 position. This was further supported by the chemical shift at δ 13.81 ppm in its ^{1}H NMR spectrum. In the ^{1}H NMR spectrum, a chemical shift at δ 6.92 (1H, s) indicates the characteristic olefinic proton of a flavone. The signal at δ 6.93 (1H, d, J = 8.2 Hz) and 7.57 ppm (as overlapped signals integrating for two protons), which accounted for H-5′, H-6′ and H-2′ for its B-ring protons respectively, clearly suggestive of oxygenation at C-3′ and C-4′. Its only one proton of the A ring was evident at δ 6.54 (1H, s), can positioned at either C-6 or C-8. The ^{1}H NMR data for apigenin 6-C-glucoside and apigenin 8-C-glucoside [12] showed that the chemical shift for H-6 is at 6.29 ppm and for H-8 is at 6.56 ppm. Comparing these with the signal at 6.54 ppm for compound II suggested the presence of a C-8 proton and substitution at C-6 in the A-ring. A three-proton singlet at δ 3.99 was attributed to a methoxyl group, which was evident at C-3′ position, was confirmed from its UV spectrum [18]. Identification of the sugar attached at C-6 as the deoxyhexosulose was consistent with observation of a non-flavonoid IR band for C=O at 1726 cm^{-1} as well as the ^{13}C NMR signal appearing at 204.4 ppm which indicated the presence of an aliphatic ketone [12]. Attachment of rhamnose to the C-6 sugar residue and not directly to a flavone oxygen was established from its LC-MS spectral data as well as hydrolysis. Treatment of II with 2N HCl (100°C, 3 hr) yielded rhamnose, identified by thin layer chromagraphy and by comparison with authenthic sugar (R_f 4.3, B.A.W., 4:1:5). Its identification was supported by the rhamnosyl –CH_3 group at 0.66 ppm (3H, d, J = 5.8 Hz), suggested it was a terminal sugar moiety. Based on the above data the structure of compound II was concluded as maysin-3′-methyl ether. The structure of II was further supported by its ESI-MS spectrum. The spectrum showed peaks at 591 (M^+), 445 (M^+ + H – rhamnose) and 315 (M^+ + H – rhamnose – deoxyhexosulose), once again confirmed the structure as maysin-3′-methyl ether. The ^{13}C NMR chemical shifts (Table **1**) were also consistent with those reported literature [13]. Based on the above data, the compound **II** was assigned as 2′′-O-α-L-rhamnosyl-6-C-(6-deoxy-xylo-hexos-4-ulosyl)-luteolin-3′-methyl ether or namely maysin-3′-methyl ether, previously isolated from this plant [12, 13]. The structures of the two isolated flavone glycosides were shown in Figure **1**.

3.2. Antimicrobial Activities of Different Organic Solvent Extracts of Corn silk

Evaluation of antimicrobial activities against four gram-positive bacteria, eight gram-negative bacteria and one yeast were carried out separately with the pet-ether (PECS), chloroform (CECS) and methanol (MECS) extracts (25 mg/mL) of corn silk. Gentamycin



Compound I **Compound II**

Figure 1: Structures of the isolated compounds **I** (maysin) and **II** (maysin-3′-methyl ether) from the n-butanol fraction of methanol extract of corn silk.

(50 μg/mL) was used as reference antibiotic. The results are shown in Table **2**. PECS and MECS were sensitive against eleven bacteria out of twelve bacteria. CECS was sensitive only against five bacteria. No extracts was sensitive against *E. coli* and *C. albicans*.

The results were compared with gentamycin, which was sensitive against all the bacteria tested. PECS (25 mg/mL) showed significantly ($p<0.05$) higher sensitivity against some bacteria than gentamycin (50 μg/ml), except against *P. aeruginosa*, *Ent. aerogenes, S. typhi*. And towards *S. paratyphi, S. sonnei and S. flexner* it showed insignificant ($p<0.05$) activity in comparison with gentamycin.

Similarly MECS showed comparatively higher activity in comparison to gentamycin against eight bacteria and the results were significant ($p<0.05$),

Table 2. Antimicrobial Activity of Different Organic Solvent Extracts of Corn Silk

Microorganisms	[1]Zone of Inhibition (mm ± S.D.)			
	Pet-ether Extract (PECS) (25 mg/ml)	Chloroform Extract (CECS) (25 (mg/ml)	Methanol Extract (MECS) (25 mg/ml)	Gentamycin (50 μg/ml)
Bacillus cereus	12.17 ± 0.22	10.98 ± 0.12	10.66 ± 0.31	8.00 ± 0.13
Bacillus subtilis	*11.16 ± 0.07	*11.08 ± 0.18	*11.27 ± 0.12	8.08 ± 0.11
Staphylococcus aureus	10.45 ± 0.22	4.58 ± 0.58	*8.61 ± 0.37	*8.00 ± 0.24
Pseudomonas aeruginosa	8.37 ± 0.13	0	10.15 ± 0.15	11.23 ± 0.21
Enterobacter aerogenes	8.61 ± 0.25	7.01 ± 0.12	11.46 ± 0.10	10.00 ± 0.01
Salmonella typhi	9.75 ± 0.19	0	11.33 ± 0.21	13.04 ± 0.19
Salmonella paratyphi	*8.5 + 0.17	0	*7.47 + 0.43	*8.01 ± 0.15
Escherichia coli	0	0	0	5.07 ± 0.06
Shigella sonnei	*10.45 ± 0.25	8.43 + 0.38	*10.55 ± 0.13	*9.98 ± 0.20
Shigella flexneri	5.94 ± 0.24	0	7.12 ± 0.09	6.01 ± 0.13
Proteus vulgaris	10.18 ± 0.21	0	*8.01 ± 0.11	*8.00 ± 0.02
Proteus mirabilis	11.22 ± 0.17	0	6.59 ± 0.35	8.03 ± 0.07
Candida albicans	0	0	0	0

[1]Values are means of three readings (± S.D.). *Values are not significant within the row ($p<0.05$).

except towards *Staph. aureus, S. paratyphi* and *S. sonnei*, where it showed insignificant ($p<0.05$) result against these bacteria. In comparison to sensitivity of CECS and gentamycin against the tested bacteria, it was observed that CECS showed poor sensitivity against gram-negative bacteria comparatively than gram-positive bacteria. Only it exerted higher sensitivity towards *B. cereus* and *B. subtilis* than gentamycin, and towards *Ent. aerogenes and S. sonnei* it showed lower activity than gentamycin ($p<0.05$).

Phytochemical investigation on PECS revealed the presence of phytosterol, e.g. stigmasterol and β-sitosterol, and mixtures of fatty acids, e.g. dodecanoic acid, tetradecanoic acid, hexadecanoic acid and octadecanoic acid [15]. MECS contained a number of flavonoids such as maysin, quercetin and maysin-3′-methyl ether [12-16]. Therefore, the different chemical constituents of the extracts could be contributed for their different ranges of antimicrobial activity.

3.3. Antimicrobial Activities of Isolated Flavonoid Glycosides of Corn Silk

Two flavonoid glycosides (compound I and II) were isolated from n-butanol fraction of methanol extract of corn silk. The chemical structures of the compounds were elucidated as maysin (**I**) and maysin-3′-methyl ether (**II**) by means of different analytical methods such as UV, IR, NMR and MS (ESI) analyses and by comparison with those reported literature for the compounds [12, 13, 18]. The antimicrobial studies of maysin (**I**) and maysin-3′-methyl ether (**II**) were studied against twelve bacteria and one yeast. The results are given in Table **3**. The sensitivity of the compounds (2.0 mg/mL) towards bacteria was compared with that of standard gentamycin (50 μg/mL). Flavonoid glycosides showed wider range of activity towards gram-positive and gram-negative bacteria. Comparatively, compound **I** exerted highest antibacterial activity towards gram positive bacteria than **II**. In comparison with gentamycin, compound **I** showed significantly ($p<0.05$) higher activity against the tested bacteria except towards *Ent. aerogenes, S. paratyphi* and *P. mirabilis* where it exerted statistically ($p<0.05$) similar activity with gentamycin. Towards *P. aeruginosa*, it showed lower activity than gentamycin.

Maysin-3′-methyl ether (**II**) showed comparatively lower activity than **I**, it seems the presence of methoxyl substitution on C-3′ position slightly decreases the sensitivity towards bacteria. Wang *et al.* [19] reported that the presence of phenolic hydroxyl groups was essential for higher antibacterial activity. In comparison the antibacterial activity of II and gentamycin, it exerted little higher activity than gentamycin towards *B. cereus,*

Table 3: Antimicrobial Activity of Flavonoid Glycosides (I and II) of Corn Silk

Microorganisms	[1]Zone of inhibition (mm ± S.D.)		
	Maysin (I) (2.0 mg/mL)	Maysin-3′-methyl ether (II) (2.0 mg/mL)	Gentamycin (50 μg/mL)
Bacillus cereus	17.45 ± 0.24	11.17 ± 0.11	8.00 ± 0.13
Bacillus subtilis	13.15 ± 0.29	10.12 ± 0.15	8.08 ± 0.11
Staphylococcus aureus	11.3 2 ± 0.14	*8.07 ± 0.18	*8.00 ± 0.24
Pseudomonas aeruginosa	8.6 7 ± 0.19	7.17 ± 0.14	11.23 ± 0.21
Enterobacter aerogenes	*10.18 ± 0.17	*10.19 ± 0.15	*10.00 ± 0.01
Salmonella typhi	*9.92 ± 0.27	*9.25 ± 0.16	13.04 ± 0.19
Salmonella paratyphi	*8.16 ± 0.11	7.01 ± 0.21	*8.01 ± 0.15
Escherichia coli	0	0	5.07 ± 0.06
Shigella sonnei	15.23 ± 0.23	12.15 ± 0.25	9.98 ± 0.20
Shigella flexneri	8.22 ± 0.16	7.11 ± 0.09	6.01 ± 0.13
Proteus vulgaris	*13.01 ± 0.18	*12.45 ± 0.21	8.00 ± 0.02
Proteus mirabilis	*8.25 ± 0.19	6.55 ± 0.11	*8.03 ± 0.07
Candida albicans	0	0	0

[1]Values are means of three readings (± S.D.). *Values are not significant within the row ($p<0.05$).

B. subtilis, S. sonnei and P. vulgaris and the results were significant ($p<0.05$). The activity towards *Ent. aerogenes* and *Staph. aureus* was insignificant ($p<0.05$) with gentamycin and towards other bacteria, gentamycin showed higher activity than II. Both compounds were not sensitive against *E. coli* and *C. albicans*.

4. CONCLUSION

From the results of antimicrobial activities of different solvent extracts of corn silk, it can be seen that extracts exhibited wider range of antimicrobial activity, petroleum ether and methanol extracts were more active than chloroform extracts. The different in activities of extracts can be ascribed for their different chemical constituents. Therefore, it can be concluded that extracts of corn silk can protect the body from different disease condition related to the pathogenic organisms.

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