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Original Article

Distributions of *Listeria* spp., *Bacillus* spp., *Enterococcus* spp., *Staphylococcus* spp., and Coliforms Isolated from Agricultural Herb Products from the Market

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The study was conducted to investigate the distribution of pathogenic bacteria related to agricultural herb products that are sold on the market in South Korea. A survey was conducted on the microbial contamination levels and antibiotic susceptibility of *Bacillus cereus* (*B. cereus*) among 194 agricultural herb products on sale in Seoul. Distributions of those isolates were 252 coliforms, 148 *Bacillus* spp., 75 *Enterococcus* spp., 10 *Staphylococcus* spp., and 6 *Listeria* spp., respectively. The number of *B. cereus* isolates was 34, *Escherichia coli* isolates was three, *Enterococcus faecium* isolate was one, and *Enterococcus faecalis* isolate was one. Antibiotic susceptibility of *B. cereus* isolates was tested against 36 kinds of antibiotic susceptibility discs by disc diffusion method. *B. cereus* isolates were resistant to 20 kinds of antibiotics and semi-resistant to 11 kinds of antibiotics. On the basis of these results, any agricultural herb product can be assumed to be resistant or semi-resistant to the antibiotics used in human. In conclusion, we suggest sanitary control and special management regarding *B. cereus* contamination in agricultural herb products.

Key Words: *Bacillus cereus*, Antibiotic susceptibility, Agricultural herb products

INTRODUCTION

Plants had been used for medicinal purposes long before recorded history (1). World Health Organization (WHO) survey indicates that about 70~80% of the world population particularly in the developing countries rely mainly on herbal medicines for their primary healthcare (2). The growth of herbal markets has increased substantially in South Korea, but the worldwide market share remains small despite significant governmental efforts (3) However, Chinese herbal medicines have successfully entered the international market, and their use is increasing worldwide (3).

Microbes might contaminate herbal medicines during storage and improper handling. Although herbal remedies are often perceived as natural and therefore safe, they are not free from adverse effect (4). With increasing popularity, the safety, efficacy and quality of these medicines have become an important issue for health authorities and health professionals (4). Counting bacterial colonies on agar plates is a simple and effective method for determining the number of viable bacteria in a sample (5). In this study, 194 agricultural herbal products were collected from Gyungdong wholesale market in Seoul. The purpose was to determine the microbial load in agricultural herbal products and ascertain the sanitation control of herb products in the market.

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MATERIALS AND METHODS

Random sampling

Agricultural herbal samples were collected by random sampling from Gyungdong herb products wholesale market of Dongdaemun-gu, Seoul, Korea, from November, 2015 to October, 2016. One-hundred and ninety-four agricultural herb products were collected, and each agricultural herb products had been identified by the number of each species. The quantities of the sample distribution were as follows: Seven were *Acanthopanax Root Bark*, eight were *Achyranthis Radix*, six were *Acori Gramineri Rhizoma*, four were *Alismatis Rhizoma*, eight were *Angelica Gigantis Radix*, four were *Armeniacae Semen*, fourteen were *Astragali Radix*, three were *Atractylodis Rhizoma Alba*, four were *Carthami Tinctoriin Fructus*, three were *Cassiae Semen*, three were *Chrysanthemum*, four were *Cinnamon Bark*, four were *Cinnamoni Cortex Spissus*, nine were *Citri Unshii pericarpium*, sixteen were *Cnidii Rhizoma*, three were *Corni Fructus*, eight were *Crataegi Fructus*, three were *Eleutherococcus senticosus*, five were *Eucommiae Cortex*, nine were *Gardeniae Fructus*, three were *Gastrodiae Rhizoma*, four were *Glycyrrhzae Radix et Rhizoma*, six were *Liriopis Tuber*, seven were *Lycii Fructus*, five were *Menthae Herba*, three were *Nelumbinis Semen*, thirteen were *Paeoniae Radix*, five were *Platycodi Radix*, ten were *Puerariae Radix*, four were *Rubi Fructus*, three were *Schisandrae Fructus*, three were *Zingiberis Rhizoma*, three were *Zizyphi Semen*.

Determination of microbial quality by aerobic plate count method

Microbial quality was determined by the aerobic plate count method using the standard protocol established by Lee *et al*. (6). Ten grams of samples were added in 90 ml 0.85% saline solution to achieve a ten-fold dilution of the original sample by BagMixer 400 (Interscience, St. Nom la Bretèche, France). Ten-fold serial dilutions were carried out up to the concentration 10^{-5} of the original sample. One ml from each dilution was poured into the petri-plate. Standard plate count agar (Oxoid, Hampshire, England) having a temperature of around 45℃ was poured and the petri-plates were rotated to distribute the sample uniformly in the media. Media on the petri-plates were allowed to solidify and then the plates were incubated at 37℃ for 24 h (4).

Determination of microbial quality by coliforms plate count

The number of coliforms was determined by a pouring method of desoxycholate agar (Difco, Sparks, MD, USA) using the same protocol as in the aerobic plate count assay.

Identification of bacterial isolates

Bacterial isolates were identified based on cultural, morphological and biochemical tests. All types of colonies obtained on tryptic soy agar plate (Oxoid) after incubating in a 37℃ incubator for 24 h were subcultured on separate tryptic soy agar plate to obtain pure cultures under the same condition. Colony characteristics on tryptic soy agar plate were studied (4). Gram staining was performed for morphological study. Different biochemical tests were performed by API 20E kit, API CHB kit, API strep kit, API staph kit, and API listeria kit (bioMerieux, Marcy l'Etoile, France).

Antibiotics susceptibility test of *Bacillus cereus* (*B. cereus*) isolates

One to two isolated colonies from the fresh culture of test bacteria were transferred into test tubes containing 1 ml of nutrient broth, and incubated at 37℃ for 3~4 h until the development of turbidity equivalent to 0.5 McFarland Nephelometer Standard. This standard is estimated to have the bacterial suspension of 1.5×10^{8} CFU/ml (4). The antibacterial study was conducted by the antibiotics disc diffusion method as described previously (7~9). Thirty-six *B. cereus* isolates were tested by 36 kinds of antimicrobial drugs discs.

RESULTS

Based on the results from each samples, the highest average aerobic plate counts were revealed in six agricultural herb products [*Acanthopanax Root Bark* (1.8×10^{5}), *Acori Gramineri Rhizoma* (7.9×10^{5}), *Atractylodis Rhizoma Alba*

Table 1. Bacterial count distribution of agricultural herb products from the market

Samples[a)]	No. of sample (n=194)	Total aerobic plate counts in 37℃ (CFU/g, SPC agar)			Total coliforms in 37℃ (CFU/g, coliform agar)		
		Incidence (%)	Average bacteria No.	Range	Incidence (%)	Average bacteria No.	Range
Acanthopanax Root Bark	7	42.9	1.8×10^5	$0\sim1.1\times10^6$	28.6	3.7×10^3	$0\sim1.1\times10^4$
Achyranthis Radix	8	87.5	1.7×10^4	$0\sim8.1\times10^4$	50.0	1.4×10^3	$0\sim8.0\times10^3$
Acori Gramineri Rhizoma	6	100.0	7.9×10^5	$3.6\times10^2\sim3.2\times10^6$	50.0	2.2×10^3	$0\sim9.1\times10^3$
Alismatis Rhizoma	4	50.0	5.2×10^2	$0\sim1.6\times10^3$	0.0	0	0
Angelica Gigantis Radix	8	50.0	5.5×10^4	$0\sim3.2\times10^5$	25.0	1.6×10^4	$0\sim9.6\times10^4$
Armeniacae Semen	4	50.0	2.0×10^3	$0\sim7.4\times10^3$	50.0	1.8×10^1	$0\sim4.0\times10^1$
Astragali Radix	14	71.4	1.3×10^4	$0\sim8.8\times10^4$	57.1	6.0×10^3	$0\sim7.8\times10^4$
Atractylodis Rhizoma Alba	3	100.0	3.4×10^6	$1.3\times10^3\sim9.7\times10^6$	100.0	4.4×10^4	$1.3\times10^3\sim6.8\times10^4$
Carthami Tinctoriin Fructus	4	0.0	0	0	0.0	0	0
Cassiae Semen	3	100.0	7.6×10^3	$2.7\times10^2\sim1.8\times10^4$	33.3	3.7×10^2	$0\sim1.1\times10^3$
Chrysanthemum	3	66.7	1.4×10^3	$0\sim2.8\times10^3$	0.0	0	0
Cinnamon Bark	4	0.0	0	0	0.0	0	0
Cinnamoni Cortex Spissus	4	100.0	1.6×10^5	$6.2\times10^2\sim8.0\times10^5$	50.0	5.4×10^1	$0\sim1.8\times10^2$
Citri Unshii pericarpium	9	66.7	7.0×10^3	$0\sim5.7\times10^4$	0.0	0	0
Cnidii Rhizoma	16	62.5	7.7×10^2	$0\sim8.0\times10^3$	25.0	7.9×10^1	$0\sim5.0\times10^2$
Corni Fructus	3	0.0	0	0	0.0	0	0
Crataegi Fructus	8	62.5	1.5×10^2	$0\sim4.2\times10^2$	0.0	0	0
Eleutherococcus senticosus	3	100.0	9.1×10^2	$0\sim2.0\times10^3$	33.3	1.9×10^3	$0\sim7.4\times10^3$
Eucommiae Cortex	5	40.0	1.8×10^2	$0\sim8.7\times10^2$	0.0	0	0
Gardeniae Fructus	9	33.3	5.6×10^2	$0\sim9.2\times10^2$	0.0	0	0
Gastrodiae Rhizoma	3	66.7	1.1×10^4	$0\sim3.3\times10^4$	0.0	0	0
Glycyrrhzae Radix et Rhizoma	4	50.0	1.6×10^4	$0\sim6.4\times10^4$	25.0	3.0×10^3	$0\sim1.2\times10^4$
Liriopis Tuber	6	33.3	1.8×10^5	$0\sim1.1\times10^6$	0.0	0	0
Lycii Fructus	7	71.4	5.9×10^6	$0\sim4.1\times10^7$	28.6	5.3×10^2	$0\sim2.4\times10^3$
Menthae Herba	5	80.0	6.4×10^4	$0\sim2.6\times10^5$	40.0	5.3×10^2	$0\sim2.1\times10^3$
Nelumbinis Semen	3	75.0	3.4×10^2	$0\sim4.8\times10^2$	0.0	0	0
Paeoniae Radix	13	61.5	5.4×10^3	$0\sim4.8\times10^4$	0.0	0	0
Platycodi Radix	5	60.0	5.0×10^4	$0\sim2.5\times10^5$	0.0	0	0
Puerariae Radix	10	60.0	1.6×10^3	$0\sim8.8\times10^3$	20.0	2.3×10^2	$0\sim2.1\times10^3$
Rubi Fructus	4	100.0	5.9×10^3	$7.0\times10^1\sim1.6\times10^4$	0.0	0	0
Schisandrae Fructus	3	0.0	0	0	0.0	0	0

Table 1. Continued

Samples[a)]	No. of sample (n=194)	Total aerobic plate counts in 37℃ (CFU/g, SPC agar)			Total coliforms in 37℃ (CFU/g, coliform agar)		
		Incidence (%)	Average bacteria No.	Range	Incidence (%)	Average bacteria No.	Range
Zingiberis Rhizoma	3	66.7	1.5×10^3	$0\sim3.4\times10^3$	0.0	0	0
Zizyphi Semen	3	0.0	0	0	0.0	0	0

[a)]*Acanthopanax Root Bark*, 오가피; *Achyranthis Radix*, 우슬; *Acori Gramineri Rhizoma*, 석창포; *Alismatis Rhizoma*, 택사; *Angelica Gigantis Radix*, 당귀; *Armeniacae Semen*, 행인; *Astragali Radix*, 황기; *Atractylodis Rhizoma Alba*, 백출; *Carthami Tinctoriin Fructus*, 홍화; *Cassiae Semen*, 결명자; *Chrysanthemum*, 국화; *Cinnamon Bark*, 계피; *Cinnamoni Cortex Spissus*, 육계; *Citri Unshii pericarpium*, 진피; *Cnidii Rhizoma*, 천궁; *Corni Fructus*, 산수유; *Crataegi Fructus*, 산사; *Eleutherococcus senticosus*, 가시오가피; *Eucommiae Cortex*, 두충; *Gardeniae Fructus*, 치자; *Gastrodiae Rhizoma*, 천마; *Glycyrrhzae Radix et Rhizoma*, 감초; *Liriopis Tuber*, 맥문동; *Lycii Fructus*, 구기자; *Menthae Herba*, 박하; *Nelumbinis Semen*, 연자육; *Paeoniae Radix*, 작약; *Platycodi Radix*, 길경; *Puerariae Radix*, 갈근; *Rubi Fructus*, 복분자; *Schisandrae Fructus*, 오미자; *Zingiberis Rhizoma*, 건강; *Zizyphi Semen*, 산조인.

(3.4×10^6), *Cinnamoni Cortex Spissus* (1.6×10^5), *Lyriopis Tuber* (1.8×10^5), and *Lycii Fructus* (5.9×10^6)]. Moreover, the highest concentration of coliforms was revealed in two agricultural herb products [*Angelica Gigantis Radix* (1.6×10^4) and *Atractylodis Rhizoma Alba* (4.4×10^4)] (Table 1). The highest incidence (100%) in aerobic plate counts was revealed in six agricultural herb products [*Acori Gramineri Rhizoma*, *Atractylodis Rhizoma Alba*, *Cassiae Semen*, *Cinnamoni Cortex Spissus*, *Eleutherococcus senticosus*, and *Rubi Fructus*], and the highest incidence (100%) in coliforms was revealed in *Atractylodis Rhizoma Alba* (Table 1).

Bacterial growth was observed in tryptic soy agar. Out of 194 agricultural herbal products, 491 bacteria were isolated based on colony morphology and different biochemical tests at 36.5℃. Out of the numbers, there were 252 coliforms, 148 *Bacillus* spp., 75 *Enterococcus* spp., 10 *Staphylococcus* spp., and 6 *Listeria* spp. respectively (Table 2 and Table 3). The incidences rates were as follows: coliforms 51.32% (252/491), *Bacillus* spp. 30.14% (148/491), *Enterococcus* spp. 15.27% (75/491), *Staphylococcus* spp. 2.04% (10/491), and *Listeria* spp. 1.22% (6/491) respectively (Table 2 and Table 3). Of them, the incidence rates of bacteria related to human diseases were as follows: *Escherichia coli* isolates was 1.2% (3/252), *Enterococcus faecalis* isolate was 1.3% (1/75), *Enterococcus faecium* isolate was 1.3% (1/75), and *B. cereus* isolates were 23.0% (34/148). Based on these observations, *B. cereus* was the most prevalent pathogenic species in the genus *Bacillus* (Table 2 and Table 3).

Out of coliforms, the most prevalent species were *Enterobacter cloacae*, *Pantoea* spp., *Cronobacter* spp., and *Serratia ficaria*. Out of *Bacillus* spp. isolates, the most prevalent species were *B. mycoides*, *B. cereus*, *B. circulans*, *B. coagulans*, and *B. megatorium*. Out of *Enterococcus* spp. isolates, the most prevalent species were *Leuconostoc* spp., *Aerococcus viridans*, and *Globicatella sanguinis* (Table 2 and Table 3).

Antibiotic susceptibility test of *B. cereus* was performed against 34 *B. cereus* isolates. *B. cereus* isolate was resistant against 20 kinds of antibiotics including Amoxicillin/clavulanic acid (AMC30), Ampicillin (AMP10), Ampicillin/sulbactam (SAM20), Bacitracin (B10), Carbenicillin (CAR-100), Cefamandole (MA30), Cefoxcitin (FOX30), Ceftriazone (CRO30), Cephalothin (KF30), Colistine sulfates (CT-10), Compound sulfonamides (S3-300), Nitrofrantoir (F300), Novobiocin (NV30), Penicillin G (P10), Polymyxin B (PB-300), Rifampicin (RD5), Sulphomethoxazole/trimethoprim (SXT25), Tetracycline (TE30), Ticarcillin (TIC75), and Trimethoprim (W5) (Table 4), and was susceptible to 14 kinds of antibiotics including Amikacin (AK30), Chloramphenicol (C30), Ciprofloxacin (CIP5), Clindamycin (DA2), Doxycycline (DO30), Erythromycin (E15), Gentamicin (CN10), Kanamycin (K30), Levofloxacin (LEV5), Oleandomycin (OL15), Oxolinic acid (OA2), Streptomycin (S10), Tobramycin (TOB10), and Vancomycin (VA30) (Table 4).

Table 2. Prevalence of *Listeria* spp., *Bacillus* spp., *Enterococcus* spp., and *Staphylococcus* spp. strains in 194 agricultural herb products from the market

	Identified strains	No. of bacteria	% (isolates/samples)
Listeria spp.	*Listeria ivanovii*	3	1.2% (6/491)
	Listeria seeligeri	2	
	Listeria grayi	1	
Bacillus spp.	*Bacillus mycoides*	59	30.1% (148/491)
	Bacillus cereus	34	
	Baciluus circulans	12	
	Bacillus coagulans	10	
	Bacillus megaterium	8	
	Brevibacillus lacterosporus	6	
	Bacillus lentus	5	
	Bacillus subtilis/amylo liquefaciens	5	
	Geobacillus stearothermophilus	4	
	Bacillus non-reactive	4	
	Bacillus licheniformis	1	
Enterococcus spp.	*Leuconostoc* spp.	35	15.3% (75/491)
	Aerococcus viridans	22	
	Globicatella sanguinis	14	
	Enterococcus facium	1	
	Enterococcus faecalis	1	
	Lactococcus lactis spp. *cremoris*	1	
	Streptococcus equinus	1	
Staphylococcus spp.	*Staphylococcus lentus*	8	2.0% (10/491)
	Staphylococcus aureus	1	
	Staphylococcus haemolyticus	1	

DISCUSSIONS

Based on the results from aerobic plate counts, samples with higher average aerobic bacteria counts were *Acanthopanax Root Bark*, *Acori Gramineri Rhizoma*, *Atractylodis Rhizoma Alba*, *Cinnamoni Cortex Spissus*, *Lyriopis Tuber*, and *Lycii Fructus*. Coliforms were prevalent in *Angelica Gigantis Radix* and *Atractylodis Rhizoma Alba* (Table 1). These results were similar to the findings from Lee *et al*.'s report (6), in which the following was observed: the total aerobic plate counts were smaller in *Astragali Radix*, *Eucommiae Cortex*, and *Zizyphi Semen*, but much was measured in *Acori Gramineri Rhizoma*, *Atractylodis Rhizoma Alba*, *Achyranthis Radix*, and *Liriopis Tuber*.

Out of 194 agricultural herbal products, 491 bacteria were isolated. Out of these number, there was 51.3% (252/491) coliforms, 30.1% (148/491) *Bacillus* spp., 15.3% (75/491) *Enterococcus* spp., 2.0% (10/491) *Staphylococcus* spp., and 1.2% (6/491) *Listeria* spp. (Table 2, Table 3). Of them, *B. cereus* was the most prevalent pathogenic species in the genus *Bacillus*, but the most prevalent species in the genus

Table 3. Prevalence of coliforms isolates in 194 agricultural herb products from the market

Identified strains	Total	% (isolates/ samples)
Enterobacter cloacae	63	
Pantoea spp.	33	
Cronobacter spp.	27	
Serratia ficaria	22	
Klebsiella pneumoniae spp. *pneumoniae*	16	
Acinetobacter baumanni/ calcoaceticus	12	
Escherichia vulneris	11	
Pseudomonas luteola	8	
Enterobacter amnigenus	5	
Klebsiella peumoniae spp. *ozaenae*	5	
Enterobacter aerogenes	4	
Klebsiella oxytoca	4	
Leclercia adecarboxylata	4	
Rahnella aquatilis	4	
Enterobacter cancerogenes	3	
Escherichia coli	3	
Escherichia heremani	3	
Serratia rubidaea	3	
Enterobacter cancerogenus	3	
Citrobacter koseri/amalonaticus	2	
Enterobacter amnigenus	2	
Pseudomonas oryzihabitans	2	
Serratia liquefaciens	2	
Serratia odorifera	2	
Aeromonas hydrophila/cariae/sobia	1	
Burkholderia cepacia	1	
Buttiauxella agrestis	1	
Citrobacter amalonaticus/farneri	1	
Citrobacter braakii	1	
Kluyvera spp.	1	
Pseudomonas aeruginosa	1	
Pseudomonas fluorescenes/putida	1	
Serratia fonticola	1	
Total	252	51.3% (252/491)

Bacillus was *B. mycoides* (39.9%, 59/148) (Table 2, Table 3). This result is comparable with the results obtained by Oyetayo (10). He assessed Nigerian herbal medicines and reported that almost all of the herbal medicines tested were contaminated with *Bacillus* spp. which is commonly found in soil, air, dust, etc. (10). Many aerobic species of *Bacillus* spp. produce endospore that helps them not only resist environmental stress but also ensure their long-term survival under adverse conditions (10). In his study, all agricultural herbal products in which microorganisms were not isolated in aerobic bacteria count showed an antibacterial property (10). The antibacterial property of agricultural herbal products might be one of the reasons that they are not contaminated by bacteria, with the exception of *Bacillus* spp. (10). Among the *Bacillus* spp., the most predominant species was *B. cereus* (23.0%, 34/148) (Table 2). Esimone *et al*. (11) had also reported *Bacillus* spp. (28.4%) as the most common organism in herbal products. The presence of *B. subtilis* and *B. cereus* observed in agricultural herbal products is comparable to a similar study conducted by Adeleye *et al*. (12). Microbial contamination usually occurs due to improper drying or storage of the plant material which eventually results in degradation of the plant constituents (4). Microbial contamination can also render plant material toxic, either by transforming the chemicals in the plant material or from the production of toxic compounds by the microbes (4). Therefore, microbial quality tests should be conducted as necessary throughout the lifestyle of the plant materials, from the raw material to the finished product stages (4). The result is comparable with the result obtained by Okunlola *et al*. (13). They had also reported the presence of *Escherichia coli*, *Salmonella* spp. and *Staphylococcus aureus* in agricultural herbal products. Similarly, the same microorganisms were also detected in this research. During the quality analysis, precautions must be taken to ensure that conditions do not adversely affect any microorganisms that are to be measured (4).

Lee *et al*. (6). reported that *B. cereus* was isolated to 50.4% (59/117) of all isolated aerobic bacteria in medicinal herb products. *B. cereus* was isolated to many numbers, possibly because most *Bacillus* spp. was originated from soil

Table 4. Antimicrobial susceptibility patterns of 34 *Bacillus cereus* isolates in 194 agricultural herb products from the market

Antimicrobial drugs	Initial	Concentration	Susceptible (%)	Intermediate (%)	Resistant (%)
Amikacin	AK30	30 μg/ml	97.1	2.9	0.0
Amoxycillin/clavulanic acid	AMC30	30 μg/ml	8.8	8.8	82.4
Ampicillin	AMP10	10 μg/ml	5.9	0.0	94.1
Ampicillin sulbactam	SAM20	20 μg/ml	11.8	14.7	73.5
Bacitracin	B10	10 units/ml	5.9	17.6	76.5
Carbenicillin	CAR100	100 μg/ml	2.9	0.0	97.1
Cefamandole	MA30	30 μg/ml	5.9	5.9	88.2
Cefoxitin	FOX30	30 μg/ml	14.8	17.6	67.6
Ceftriazone	CRO30	30 μg/ml	2.9	11.8	85.3
Cephalothin	KF30	30 μg/ml	5.9	0.0	94.1
Chrolamphenicol	C30	30 μg/ml	58.8	29.4	11.8
Ciprofloxacin	CIP5	5 μg/ml	52.9	47.1	0.0
Clindamycin	DA2	2 μg/ml	64.7	14.7	20.6
Colistine sulphates	CT10	10 μg/ml	2.9	0.0	97.1
Compound sulphonamides	S3-300	30 μg/ml	38.2	11.8	50.0
Doxycycline	DO30	30 μg/ml	82.3	11.8	5.9
Erythromycin	E15	15 μg/ml	76.5	5.9	17.6
Gentamicin	CN10	10 μg/ml	100.0	0.0	0.0
Kanamycin	K30	30 μg/ml	52.9	44.2	2.9
Levofloxacin	LEV5	5 μg/ml	97.1	2.9	0.0
Nalidixic acid	NA30	30 μg/ml	23.5	58.9	17.6
Neomycin	N10	10 μg/ml	26.4	61.8	11.8
Nitrofrantoir	F300	300 μg/ml	29.4	20.6	50.0
Novobiocin	NV30	30 μg/ml	5.9	26.5	67.6
Oleandomycin	OL15	15 μg/ml	52.9	2.9	44.2
Oxolinic acid	OA2	2 μg/ml	88.2	0.0	11.8
Penicillin G	P10	10 units/ml	0.0	0.0	100.0
Polymyxin B	PB300	300 units/ml	2.9	44.2	52.9
Rifampicin	RD5	5 μg/ml	0.0	0.0	100.0
Streptomycin	S10	10 μg/ml	82.3	11.8	5.9
Sulphamethoxazole/trimethoprim	SXT25	25 μg/ml	23.5	3.0	73.5
Tetracycline	TE30	30 μg/ml	32.4	17.6	50.0
Ticarcillin	TIC75	75 μg/ml	0.0	2.9	97.1
Tobramycin	TOB10	10 μg/ml	79.5	17.6	2.9
Trimethoprim	W5	5 μg/ml	0.0	0.0	100.0
Vancomycin	VA30	30 μg/ml	100.0	0.0	0.0

and that isolate's spore.

Antibiotic susceptibility tests were performed on 34 *B. cereus* isolates. Over 50% of *B. cereus* isolates were resistant to antibiotics.

Most of the agricultural herbal products had a large number of coliforms and *Bacillus* spp. and *B. cereus* isolates from agricultural herbal products showed significant resistant patterns to the antibiotics tested.

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