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Response of Cut Carnation cv. Tempo to Essential Oils and Antimicrobial Compounds

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Abstract: ***Carnation cut flower is sensitiveto ethylene, which its*** **vase life** ***reduces depending on ethylene production and vascularocclusion. Like other cut flowers, carnation is sensitive to bacteria*****l infection on*****stem end, bacteria*****l contamination*****producestoxic compoundsandit affects ethylene production*****that ultimately shortens vase life. In order to study on effect of essential oils, 8-hydroxyquinoline sulphate and aluminum sulphate on vase life and postharvest characteristics of cut carnation (Dianthus caryophyllus L. cv. Tempo), a RCD experiment with 13 treatments: Artemisia oil at 3 levels (4, 8 and 12%), Anethum oil at 3 levels (4, 8 and 12%), 8-hydroxyquinoline sulphate at 3 levels (200, 400 and 600 mg l^{-1}) and aluminum sulphate at 3 levels (100, 200 and 300 mg l^{-1}), 3 replications, 39 plots and 156 cut flowers was carried out. The measured traits were stem end bacterial clonies population, ethylene production, water uptake, fresh weight loss and vase life. The results showed that 100 mg l^{-1} aluminum sulphate, 200 mg l^{-1} 8-hydroxyquinoline sulphate, 12 % Artemisia and Anethum oils were the best treatments and enhanced vase life& qualitative features.**

Keywords: **Carnation, Artemisia oil, Anethum oil, Aluminium sulphate, 8-hydroxyquinoline sulphate, vase life, number of bacteria in vase solution, petal protein.**

1. INTRODUCTION

Carnation (*Dianthus caryophllus* L.) is native to the Mediterranean region to Central Asia, belongs Caryophyllaceae family that has long been under cultivation [25]. Carnation is among the world's top three cut flowers. The two species *Dianthus barbatus*&*Dianthus caryophyllus*are cultivated as commercial varieties [13]. Carnation cut flowers are so sensitive to ethylene that causessenescence and vase life reduction [19].Carnation is also susceptibletothe bacterial contamination on stem end, that producestoxic compoundsandaffects ethylene productionwhich reduces vase life which has petal's enrolling as its most obvious sign of senescence [4- 31].Given thepublicity of this problem among cutflowers, it seemsto be necessary to find a solution.Essential oilsact asincorporatingenvironmentally friendlyandhighly effectiveantimicrobial compounds[9-27]. Herbal essential oilsare natural compounds thatare knownassecondary metaboliteswhich havepowerful effectonpathogens control and their antimicrobialimpact is provenas well that increases thevase life ofcut flowers and their use is becoming widespread recently [39-41]. Artemisia (*Artemisia dracunculus*) belongs to Asteraceae family that has lots of medical properties, Dill (*Anethumgraveolens*) is an annual or biennial plant that sometimes reaches its height to one meter [34].Mousavi Bazaz & and Tehranifar[32]investigated the effects of cumin, mint and thyme extract (50 and 100 mgl^{-1}) and ethanol (4 & 7%) on the vase life of cut Alstroemeria (*Alstroemeria* sp.) and concluded that all treatments had a positive effect on vase life and water uptake and also 50 mgl^{-1} thyme extractextended vase life about 2 days more than the control.Solgi et al.[40]studied on the effect of different herbal essential oils including Carvacrol, Thyme oil and Zatariya essential oil & silver nanoparticles on the vase life of gerbera (*Gerberajamesonii*cv. 'Dune'), and reported that treatment with 50 and 100 mgl^{-1} carvacrol increased the vase life of about 8 days as compared to the control.8-hydroxyquinolinesulfate orcitrateare usedmainly to acidification of the solutionandcombined withdivalentionssuch as ironand copperto prevent vascularocclusion, that canprevent enzymatic activities which lead to vascular blockage[9-21].Tar& Hassan[42]evaluated the effect ofvarious levelsof 8-hydroxyquinolinesulfateon the postharvest life of *Aster*sp. cut flowerandconcludedthat the use of400$mgl^{-1}$of this compound increases the vaselife.It is proved that using calcium, aluminum, boron, nickel & zinc salts can extend vase life of cut flowers [9].

In addition tothe inhibitoryeffect ofaluminum sulfateon microorganisms activity, it reducesthe transpiration of cut flowers.It appears considering the carnation leaves shape and cuticle thickness, the effects ofaluminum sulfateon reduction of transpiration andstomatalexchange rate is less.Previous studies show that the use of aluminum sulfate, especially at high concentrations may cause damage to the leaves of some flowers such as roses (*Rosa hybrida* L.) [10].Liaoet al. [30]investigated the effect ofaluminum sulfateat different concentrations(50, 100 & 150 mgl^{-1}) on thevase lifeofcut *Eustoma grandiflora* and concluded that using150mgl^{-1}increased vase lifeup to15.4 days. Additionally, aluminum sulfate enhanced water uptake and fresh wight. Hojati et al. [20] investigated different chemicals like cobalt chloride and aluminum sulfate on *Eustoma grandiflora* vase life and resulted that aluminum sulfate extends vase life of cut flowers.This study is about comparison the effect of different concentrations of herbal essential oils and other antimicrobial compounds on the vase life of cut carnation cv. 'Tempo'.

2. MATERIALS AND METHODS

Cut carnation (*Dianthus caryophyllus*L. Cv. 'Tempo') provided from a commercial manufacturer's and were equalizedat 50 cm height, then they were re-cut from stem end; it's because of vascular blockage inhibition. Then they immediately transferred to the postharvest laboratory with the following condition: 12 $\mu Ms^{-1}m^{-2}$ light intensity, 20± 2° C temperature, 12 hours day length and a relative humidity of 60 to 70 percent to traits assessment.5 cutflowerswere placed ineachplastic2 lit volume vase andthen were treated withspecificconcentrationsofantimicrobial compounds.

This experiment is based on a completely randomized design with13treatments(*Artemisia* essential oil at 3levels (4, 8and 12%);8-hydroxyquinolinesulfateat3levels(200, 400&600mgl^{-1}) andaluminum sulfateat3levels(100, 200and300mgl^{-1}) alongwith controlplotswas carried outin3replicates and39 plots.The pulse treatment completed after 24 hours then flowers were transferred into other vases containing 500 ml3% sucrose+200mgl^{-1}8-hydroxyquinolinesulfate preservative solution.

Themeasured traits were vase life, fresh weight loss, water uptake, ethylene production and bacterialpopulations on the stem end. Vase life is characterized with leaf wilting index or leaf senescence and flowers wilting (fig. 1) [33]. Toevaluate thefresh weight loss, flowers fresh weightwere measuredat the first & the last day of vase life, and also considering the re-cut part weight, their difference were recorded.Due to the preservative solution initial content (500 ml), the absorption was measured according to each day reduction (both evaporation & stem uptake), the solution absorption was calculated &has been divided to the initial flowers weight.To measurethe amountof ethylenereleasedfromeach pot, aflowerwere selected andafter cutto25 cm was weighted & then transferred into smallerpotscontaining30ml 8 - hydroxyquinolinecitrate250 mgl^{-1}& each small pot was placed inside jars and sealed completely.

In order tosampletheair insidejars, wooden doorsof each jar was equipped with aseptum. Gassamples were taken to Tehran UniversityGas Analysis Laboratory. The released ethyleneproducedwith the flower were measured with C-8 AIT measuring device Shimadzumodel.Forstem end bacterial population counting, about 2 cm(0.5 g) werecutfromthe stem end 24hours aftertreatment withantimicrobial compounds; also forpreservative solution bacterial population counting counting, a 2ml sample were isolated from each pot and the evaluation were performed according to Liu et al. [30]method.

3. RESULTS AND DISCUSSION

3.1. Vase life

Analysis of variance showed that the effect of different treatments on vase life was statistically significant at 5% level. Mean comparisons revealed that100 mgl^{-1} aluminum sulfate, 200 mgl^{-1} 8- hydroxyquinoline sulfate, 12%Artemisia & Tarragon essential oils were the most effective treatments with 17.9, 16.7, 16.1 & 15.1 days vase life respectively (Tab. 1, Fig. 2). On present study, vase life enhancement can be described with antimicrobial properties of the mentioned compounds that water absorption improvement with vascular blockage prevention so it delays water deficiency related wilting [8-22].JaliliMarandiet al.[22]investigated the effects ofsalicylic acid, herbal essential oilsand silver thiosulfate (STS) on thevase lifeof cut rosesandfound that *Carumcopticum*ess ential oil at the concentrationof 500mgl^{-1}significantly(about 2 days) improved thevase life as compared to the control.Mousavi Bazaz & Tehranifar [32]on theirstudyon*Alstroemeria*& herbal essential oils, ethanol and methanol impact, found that treatmentwith 50&100mgl^{-1}had the best effect on water absorption and vase life.Solgi et al.[40] studieddifferent compounds effect on cut gerbera cv. 'Dune'and resulted that 50 & 100 mgl^{-1}caused a two-fold increase on vase life as compared to the control .Faraji [14] found that 8-hydroxyquinoline citrate & aluminum sulfate had the best impact on vase life extend, flower diameter, opening percent and flower quality of cut rose cv. 'Marosia'.

Liao et al.[29]examined the effects of aluminum sulfate at concentrations of 50, 100, and 150 mgl^{-1} on cut Lisianthus (*Eustomagrandiflora*) and concluded that 150 mgl^{-1} of that extends vase life up to 15.4 days, additionally aluminum sulfate enhanced water uptake and fresh weight.Hojjatiet al. [20] investigated the effect ofdifferent chemicaltreatmentslike cobalt chloride and aluminum sulfate onvase lifeofcut Lisianthus and found thataluminum sulfate canincrease vase life.Khan et al.[26]studied the effect of aluminum sulfate and sucrose on the properties tulip (*Tulipahybrida*) properties and concluded that aluminum sulfate increases the relative water content in leaves and petals 64.5% & 58.7% respectively.Anju et al.[2]examined the effect of 8 - hydroxyquinoline citrate and sucrose on the vase life of cut chrysanthemum (*Chrysanthemummorifolium* L.) and found that these compounds caused an increase in fresh weight and vase life as compared to the control.Tar &Hassan[42]investigated the impact of various levels of 8-hydroxyquinoline sulfate on (*Aster* sp.) vase life and concluded that the use of 400 mgl^{-1} of this compound increases vase life.

3.2. Fresh weight loss

Analysis of variance showed that the effects of different treatments on fresh weight reduction was significant at the 5% level. Mean comparisons also revealed that 100 mgl^{-1}

aluminum sulfate, 200 mgl^{-1} 8-hydroxyquinoline sulphate and 12% Artemisia & Dill essential oil were the most effective treatments with 2.89, 4.2, 4.4 & 4.3 grams loss respectively (Fig. 3, Table 1). Water uptake and water relations improvement with antimicrobial compounds prevent fresh weight loss [6- 15-43].Liaoet al. [30] on their investigation on cut Lisiyanthusand applying different aluminum sulfate concentrations found that aluminum sulfateenhancedfresh weight as compared to the control. Theresearchersalso described this enhancement with abettercorolla outreach. Hydroxyquinolineenhanced cut roses fresh weight and vase life significantly [21]. These results are in accordance with [11-3-28].

3.3. Water absorption

The analysis of variance showed that the effects ofdifferenttreatments onwater absorptionwassignificantat 5% level. Mean comparisonsshowedthat amongall treatments, 100 mgl^{-1} aluminu sulfate, 200 mgl^{-1}8–hydroxyquinoline sulfate and 12% Artemisia & Dill essential oil with 1.96, 1.94, 1.80 & 1.78 mlg^{-1} F.W. gave the best results(Fig.4, Tab. 1).Improving water relations and hydraulic conductivity in cut flower arises from vascular obstruction prevention which ultimately will improves water absorption [16].Another reason for superiority of mentioned compounds is microorganisms activity control (bacteria & fungi) that prevents vascular obstruction. Ourresultsmatches with [22-7].Nabigol et al. [33] found that antiseptic and anti ethylene compoundsand also antibiotics increases water absorption significantly.Anjuet al. [2] studied the effect hydroxyquinoline and sucroseonvase life of chrysan themum (*Chrysanthemum morifolium* L.)andconcludedthat thesecompoundscaused an increase infresh weightandvase lifeand improvingqualityin comparisonwith the control.Khanet al. [26] investigated the impact ofaluminum sulfateandsucroseon theproperties oftulip(*Tulipa hybrida*)and resulted that aluminum sulfateincreases therelative water contentinleavesandpetals 64.5% and 58.7% respectively.

3.4.Bacterial population on stem end

Analysis of varianceshowed that theeffects of differenttreatments onstemend bacterial population wassignificantat 1% level. Mean comparison revealed thatamongall treatments, 100mgl^{-1}aluminumsulfate 200 mgl^{-1}8-hydroxyquinolinesulfate and 12% Artemisia & Dill essential oil were the most effective treatments that have 14, 25, 29 & 30.4 $log_{10}CFUml^{-1}$ population respectively that have a reduction as compared to the control stem ends bacterial contamination (Fig.5, Tab. 1).The effect of antimicrobial compounds used in these experimentsis defined by disrupting the pathogens function & the respiratorychainwhich prevents pathogens activity and ultimatelycause death (18-40). Esfandiariet al.[12]on their experiment on cut lily(*Lilium longiflorum* cv. 'Shoching') found that antimicrobial compoundsextends vase life by interfering bacterialcell division, these results are in accordance with Liu et al. [30]& Shanan [38] about positive impact of antimicrobial compounds and herbal essential oils on pathogenic contamination control and vase life improvement.Kazemi and Ameri [23]investigated the effercts of herbal essential oils, silver nanoparticlesand salicylic acid on bacterial contamination of carnationand found that all treatments significantly reduced bacterial populations much more than the control.Kazemi et al.[24]showed thattheuse of vase lifeextending compounds at 1.5 & 3 mM concentrations decreasedcarnation cut flower bacterial population significantly(bout 30-35%).Anjuet al.[2]examined the effects of hydroxyquinolineandsucroseonvaselife ofcut chrysanthemum (*Chrysanthemum morifolium* L.) and concluded that these compound senhance fresh weightandimproves vase lifeand qualitytraits in comparison with the control.Oraee et al. [35]investigated the effect of different levels ofsilver nanoparticles and Thyme essential oilon vase life and bacterial popultaions on stem end & in preservative solution of cut gerbera, they found that all these compounds had apositive effect incontrollingbacterial contaminations, they reported that 100 mgl^{-1} Thyme oil and 4 mgl^{-1} silver nanoparticles with two-fold increasein vase life were the most effective treatments.Hojjatiet al.[20]evaluated the effects ofdifferent chemicaltreatmentssuch as cobalt chloride and aluminum sulfate onvase lifeofcut Lisiyanthus and reported that aluminum sulfatetreatmentincreased thevase lifeand improvedpostharvest quality.Elgimabi and Ahmed [11]studied on the effects of8-hydroxyquinoline sulfate and sucrose on cut roses vase life and found that 100 mgl^{-1} 8-hydroxyquinoline sulfate caused doubled vase life for treated flowers as compared to the control and also enhanced other vase life related indexes.

3.5. Ethylene production

Analysis of varianceshowed that theeffects of differenttreatments onethylen productionwassignificantat 5% level. Mean comparison revealed thatamongall treatments and100mgl^{-1}aluminumsulfate 200 mgl^{-1}8-hydroxyquinoline were the most effective treatments with 0.201 & 0.214 nll^{-1} per hour per gram fresh weight significantly less ethylene concentration respectively (Fig. 6, Tab. 1).The impact of these antimicrobial compounds on cut carnation quality enhancement is obvious given the role of antimicrobial compounds on the uptake and transport of nutrients, reduced respiratory rate and reduced the amount of ethylene. Our findings in reducingethylene production matches with[17]. Reid et al. [36]found that the use of STS on cut carnation cv."White Seam" in the 1 to 4 molar ratio between silver and thiosulfate was satisfactory. Antiethylene and antimicrobial compounds due to their stem end bacterial contamination control, can stimulate ethylene production indirectly, can control ethylene production and extend vase life of cut carnation and gerbera (4-5-28). The results of mentioned studies about ethylene production control is consistent with the results of the current study.

Figure 1.Cut carnation cv. 'Tempo' at the last day of vase life

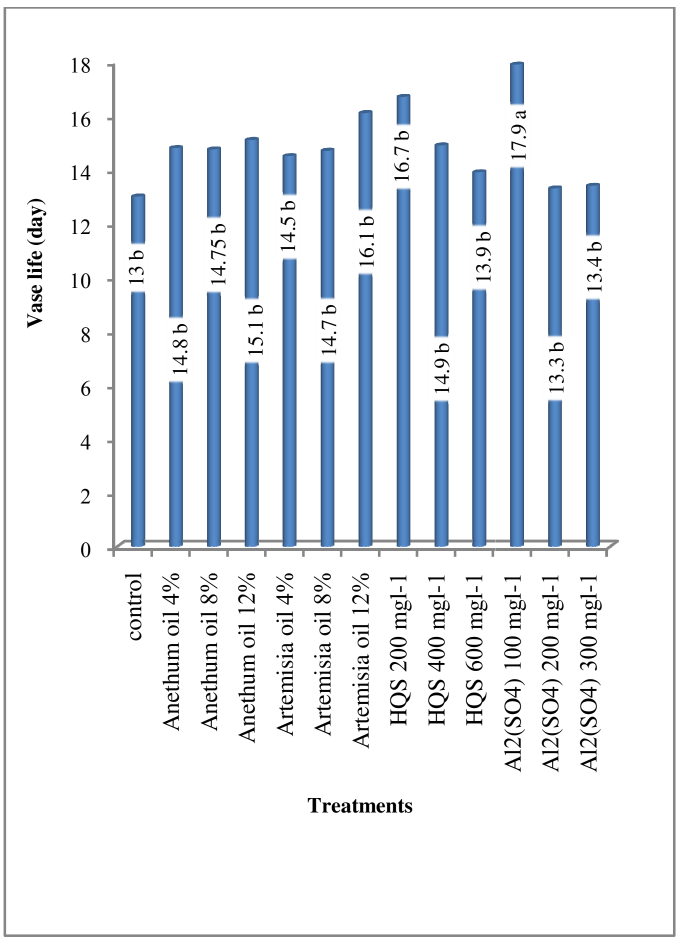

Figure 2.Effect of different treatments on vase life of cut carnation cv. 'Tempo'

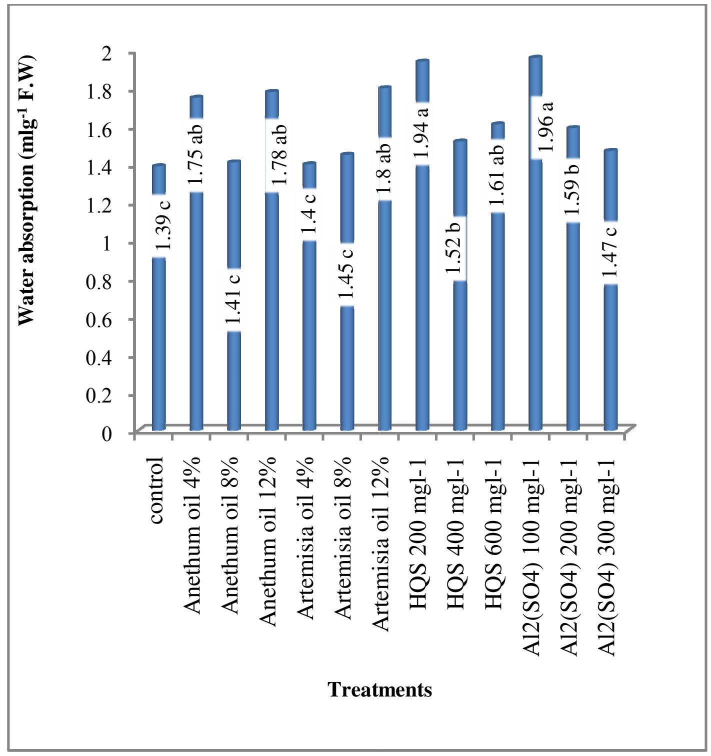

Figure 3.Effect of different treatments on water absorption of cut carnation cv. 'Tempo'

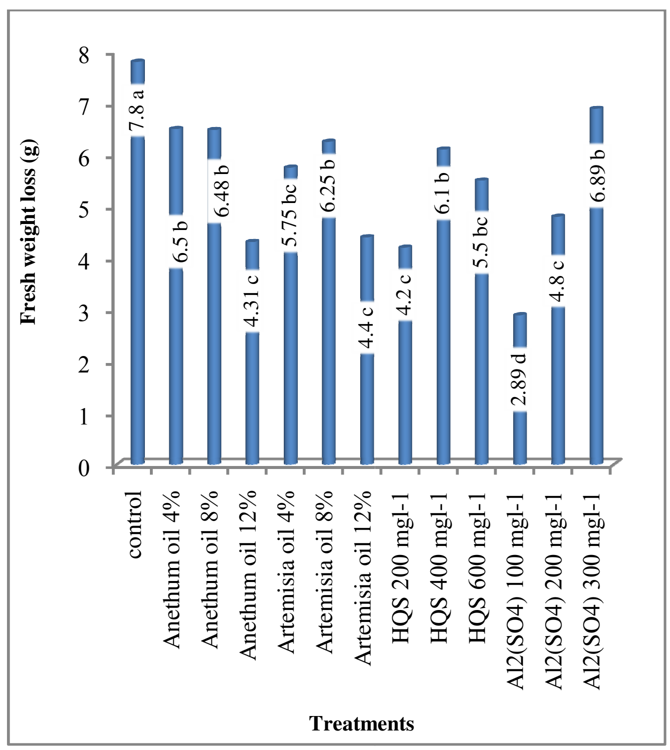

Figure 4.Effect of different treatments on fresh weight loss of cut carnation cv. 'Tempo'

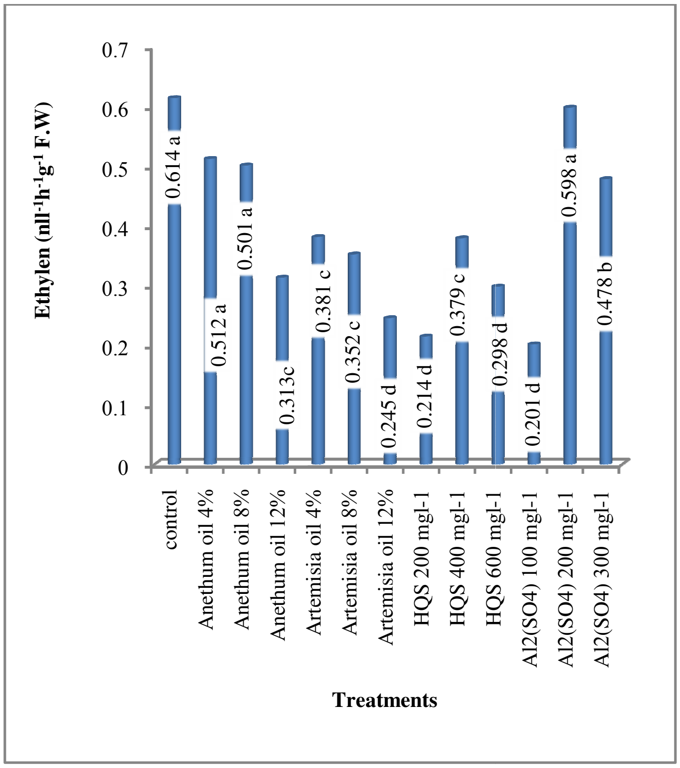

Figure 5. Effect of different treatments on ethylene production of cut carnation cv. 'Tempo'

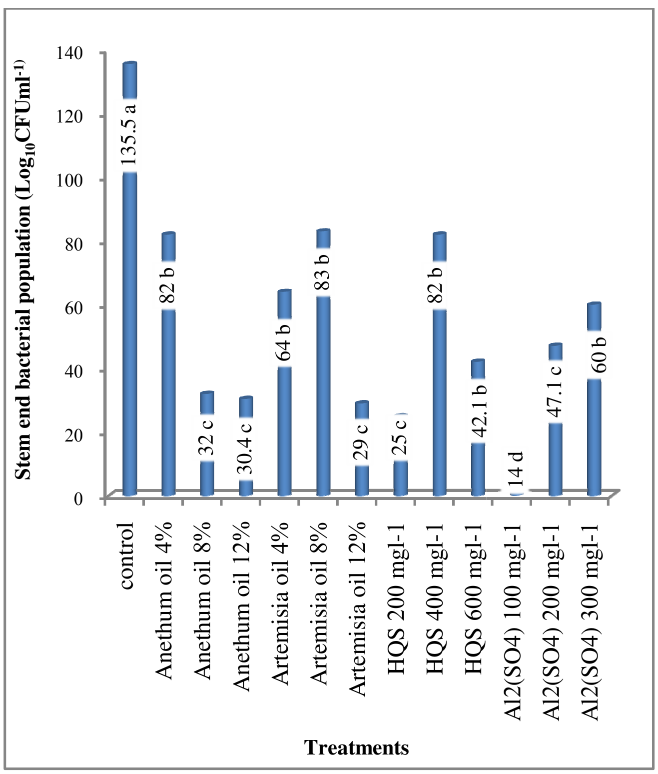

Figure 6.Effect of different treatments on stem end bacterial popultaion of cut carnation cv. 'Tempo'

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