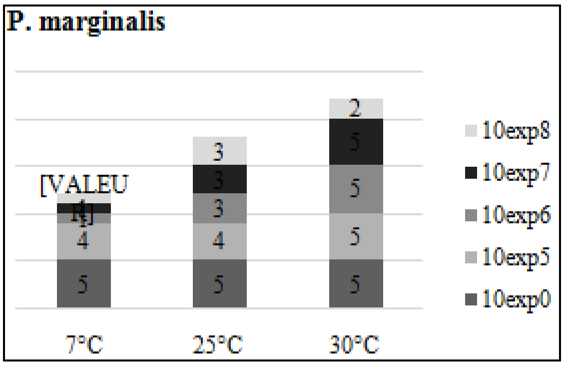


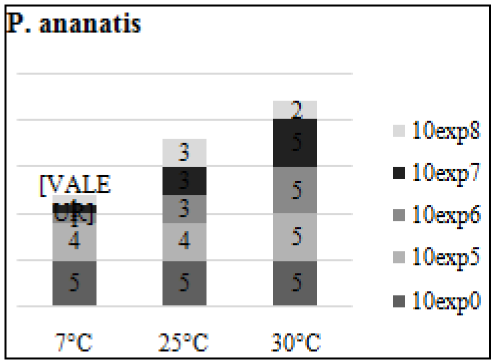
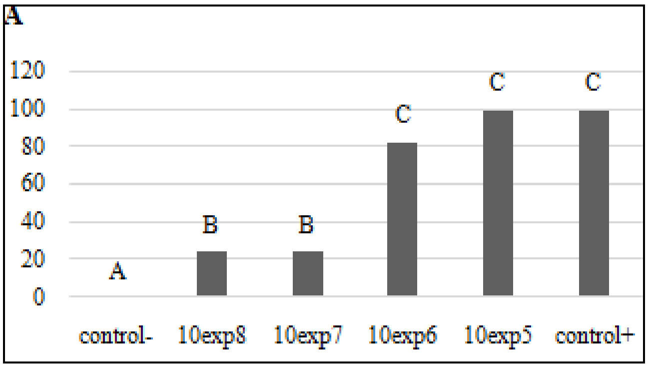
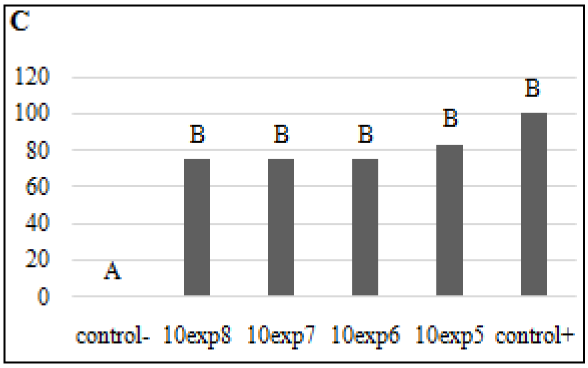


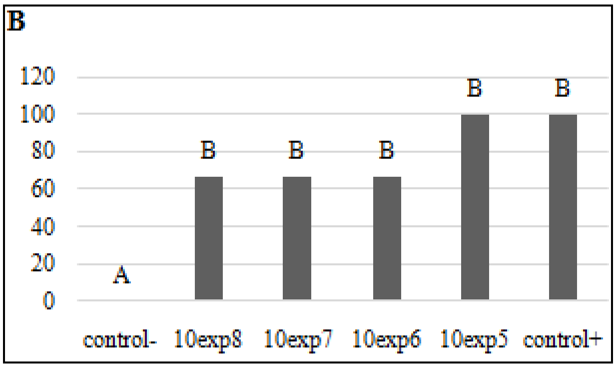
Figure 5: Severity caused by onion bacterial diseases in the presence of differences concentrations of *Pantoea agglomerans* 2066-7.

Table 6: Incidence (percentage of infected wounds) on onion bulbs protected with different concentrations of *Pantoea agglomerans* (2066-7) on the presence of 10^5 UFC $ml^{-1}$of *Pseudomonas viridiflava*, of *Pseudomonas marginalis*, *Pantoea ananatis* and of *Xanthomonas retroflexus.*

*P. agglomerans*2006-7																				
X. retroflexus					*P. ananatis*					*P. marginalis*					*P. viridiflava*					
10^8	10^7	10^6	10^5	10^0	10^8	10^7	10^6	10^5	10^0	10^8	10^7	10^6	10^5	10^0	10^8	10^7	10^6	10^5	10^0	
50	25	75	50	100	25	25	25	50	100	0	0	0	100	100	0	0	75	100	100	7°C
100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	0	0	75	100	100	25°C
25	100	100	100	100	100	100	100	100	100	100	100	100	100	100	0	75	75	100	100	30°C







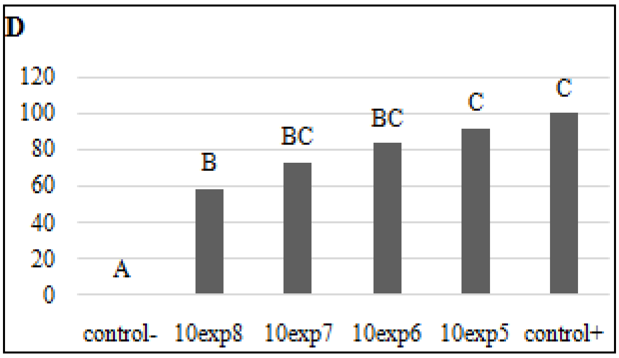


Figure 6: Influence of antagonist concentration on incidence caused by *P. viridiflava* (A), *P. marginalis*(B), *P. ananatis* (C) *and X. retroflexus*(D). The treatments having same letters are not significantly different (P <0.05).

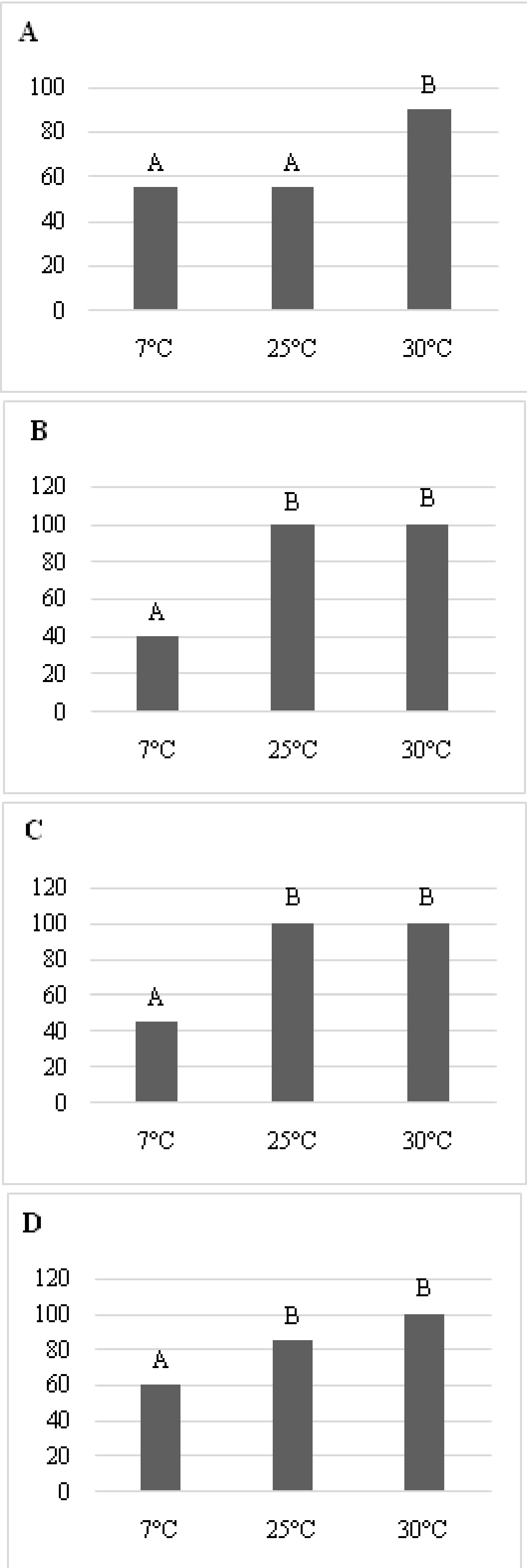


Figure 7: Influence of temperature on incidence caused by *P. viridiflava* (A), *P. marginalis*(B), *P. ananatis*(C) *and X. retroflexus* (D)in the presence of *P. agglomerans.* The tested temperatures were 7°C, 25°C and 30°C. The treatments having same letters are not significantly different (P <0.05).

5. Discussion

From 77 tested microorganisms, only 43%, 23%, 17% and 8% reduced *P. ananatis*, *P. viridiflava*, *X. retroflexus* and *P. marginalis* growth in vitro respectively. Then, numerous studies have indicated a potential for biological control of post-harvest diseases using microbial antagonists [17]-[18]-[19]-[20]-[21]. Moreover, the results of the present study demonstrate that *P. agglomerans* (2066-7) is the most effective biocontrol agent against onion bacterial diseases caused by *P. marginalis*, *P. ananatis*, *P. viridiflava* and *X. retroflexus* with a percent inhibition of 24,78% 25.55%, 26.66% and 14.44% respectively. Thus, strains of *P. agglomerans* have been previously reported as being effective in suppressing bacterial and fungal diseases [22]-[23]-[24]-[25]-[26]-[27]

An important attribute of a successful biocontrol agent is the ability to be efficient at low concentrations [7] and the effectiveness of the biocontrol agent is related to the number of viable cells [20]-[21], and to reach effective control it is sometimes necessary to use very high concentrations of the antagonist.

In vivo and under cold conditions the 2066-7 strain of *P. agglomerans* conformed to this prerequisite by being effective against onion bacterial diseases in Morocco with an inhibition percent higher than 90% at a concentration of 10^6 CFU ml^{-1}, (complete control against *P. marginalis* and *P. viridiflava* at 10^7 CFU.ml^{-1}). Sharma *et al.*, 2009 demonstrated that, for its effective control, a microbial antagonist should have the ability to grow, multiply, and suppress the pathogen at low temperature. These results indicates an excellent adaptation of 2066-7 to cold storage temperatures, a necessary feature for a postharvest biocontrol agent [7]. However, under the temperatures of 25 and 30°C, control of pathogen was reported against the four pathogens only at 10^8 CFU.ml^{-1}. These results confirmed the results obtained by McLaughlin *et al.*, 1990; El-Ghaouth *et al.*, 2004 and Nunes *et al.*, 2001 [28]-[29]-[4], who improve that in general, microbial antagonists are most effective in controlling postharvest decay on fruits and vegetables when applied at a concentration of 10^7–10^8 CFU/ml, and rarely, higher concentrations are required.

The biocontrol activity of microbial antagonists with most harvested commodities increased with the increasing concentrations of antagonists and decreasing concentrations of pathogen, this qualitative relationship, however, is highly dependent on the ability of the antagonists to multiply and grow at the wound site [30]. In this study, we found that *P. agglomerans* 2066-7 strain has an antagonist effect against onion bacterial disease; also, the most important effect of this antagonist was observed under 7°C at 10^8 CFU ml^{-1}.

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