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Short Communication

Carbon nutrition in relation to growth of three *Monascus* species isolated from decaying date fruits

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The utilization of ten different carbon sources for growth by three *Monascus* species isolated from date palm fruits has been studied. *Monascus purpureus* utilized fructose very well when compared to *Monascus ruber* and an unknown *Monascus* species. The *Monascus* sp. appeared to utilize maltose better, while sucrose and lactose were utilized well by *M. purpureus. M. ruber* utilized galactose well, but starch, mannitol and glycerol were poorly utilized. *M. purpureus* utilized raffinose and starch very well. The Monascus sp. utilized starch well, but not when compared with *M. purpureus*. Out of the ten carbon sources studied, mannitol and glycerol were poorly utilized by the three *Monascus* spp. Starch, maltose and fructose were the best carbon sources utilized by the three *Monascus* species. *M. purpureus* exhibited better utilization of the ten studied carbon sources.

Key words: *Monascus* species, carbon nutrition, date fruits, utilization.

INTRODUCTION

Monascus is a filamentous fungus that has been used to make rice wine, soya bean cheese and anka (red rice) in many Asian countries (Juslova et al., 1996). Carbon source, nitrogen source and pH have been shown to influence pigment production by *Monascus purpureus* (Su, 1978; Wong et al., 1981; Lin and Demain 1991; Chen and Johns 1993). Pigments produced by *M. purpureus* offer a possible alternative to certified food dyes or natural pigments used currently (Dweek, 2002). Carbon and nitrogen are known to be some of the most essential elements required by fungi for their growth (Cochrane 1958; Oritsejafor, 1986). However, not all sources of carbon or nitrogen are good for growth of a particular fungus and some fungi may utilize one source of carbon better than the others. The susceptibility of a crop would therefore depend on the possession of a nutritional environment that would support the growth and sporulation of a pathogen (Oritsejafor, 1986).

Omamor (1991) reported in a study that about 66.67% of the total deteriorating date fruits investigated was infected by *Monascus* spp., either alone or in combination with other pathogens particularly during the wet season. Presently, there is no information on the utilization of different sources of carbon by *Monascus* spp. isolated from date fruits. The aim of this study was therefore to determine the relative amount of growth of three *Monascus* spp. when supplied with an equivalent amount of carbon from ten different sources. The information derived from this study would lead to a better understanding of the nutritional requirement and relationship of these fungi with their host (date fruits).

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MATERIALS AND METHODS

Fungal isolates

Monascus purpureus Went, accession number 314369, *M. ruber* van Tieghem 313379 of International Mycology Institute (IMI) and an unknown *Monascus* sp. used in this study were isolated from deteriorating stored date fruits in Dutse, Jigawa state of Nigeria and were identified by the Commonwealth Mycological Institute, Surrey. Cultures were maintained on Potato Dextrose Agar (PDA) at 24^{o}C.

Screening of different carbon sources

Ten carbon sources (fructose, glucose, galactose, maltose, sucrose, lactose, mannitol, glycerol, raffinose hydrate and starch) were screened. Seven day-old PDA pure cultures from each of the *Monascus* spp. (6 mm disc) were used for inoculation. The fermen-

Table 1. Utilization of ten carbon sources by three *Monascus* species.

Carbohydrate Source	*Monascus rubber*(mg/30ml)	*Monascus purpureus*(mg/30ml)	*Monascus* sp.(mg/30ml)
Hexoses			
Fructose	16.85c	17.00c	14.57d
Glucose	13.25a	13.29a	12.37c
Galactose	17.12c	13.50a	8.75a
Disaccharides			
Maltose	21.50f	34.75j	41.00l
Sucrose	11.50c	15.30d	11.00c
Lactose	8.50a	9.00a	8.50a
Trisaccharides			
Raffinose hydrate	16.33c	18.00d	12.83a
Polysaccharides			
Starch	29.00a	52.83h	49.58g
Sugar alcohols			
Mannitol	8.50c	13.57e	4.50a
Glycerol	3.50a	5.50b	4.50a

mentation medium described by Lin and Demain (1991) was used. The basal medium consisted of yeast extract 2.0 g; KH_2PO_4, 0.05 g; $MgSO_4.7H_2O$, 0.5 g; $FeSO_4$, 0.5 g; KNO_3, 1.50 g and 1000 cm^3 of deionized water. To study the effect of the ten different carbon sources, the liquid medium was supplemented separately with 1% of each carbon source and the pH of the medium was adjusted to pH 6.0 – 6.5. The media were dispensed in 30 ml aliquots into the culture vessels, plugged with sterile cotton wool and sterilized at 121^oC for 15 min. The culture vessels were incubated at 24^oC ± 2 for 10 days Biomass production was determined using the procedure of Chandra and Purkayastha (1977).

RESULTS

The fungi utilized the hexose sugars well. *M. ruber* utilized fructose and galactose similarly, while growth in glucose was significantly less than those in fructose and galactose. *M. purpureus* utilized glucose and galactose similarly, while growth in fructose was significantly more than in galactose or glucose. For the unknown *Monascus* sp., growth in fructose was significantly more than in glucose or galactose and growth in glucose was signify-cantly more than in galactose. The *Monascus* species did not appear to utilize galactose very well (Table 1).

Lactose was poorly utilized by the three fungi (Table 1). The growth in lactose by these fungi was less than their growth in maltose or sucrose. Maltose supported good growth of the three fungi, however, *Monascus* sp. was significantly more compared to *M. purpureus* and *M. ruber*. Growth in sucrose for the three fungi was fair and was not significantly different. Raffinose supported good growth of the fungi; however, growth of *Monascus* sp. was significant less when compared to the other fungi.

Starch proved to be the best source of carbon for the three fungi (Table 1) . For *M. purpureus,* growth in mannitol was good and significant when compared to *M. ruber* and *Monascus* sp. Growth of the three fungi in glycerol was considered poor. The best carbon sources in this study were starch, maltose, fructose, raffinose hydrate, galactose and glucose, respectively.

Similar letters in the same column showed no significant difference at P = 0.05. Different letters in the same column showed significant differences at P = 0.05 using T-Test analysis of variance.

DISCUSSION

Fungi differ in their ability to utilize carbon compounds for growth, but it is frequently expected that species of the same genus are similar in their ability to utilize the carbon in different carbon sources. The findings in this study confirmed an earlier study that hexoses and disaccharides, except lactose, supported good growth for virtually all cultivated fungi (Cochrane, 1958). Thus, the ability of the three *Monascus* spp. to utilize fructose, glucose and sucrose endowed them with the ability of infecting and causing rotting of date fruits, which consist of mainly fructose, glucose and sucrose (Omamor, 1991). The utilization of glucose may be due to the ease with which this sugar was metabolized to produce cellular energy (Garraway and Evans, 1994). Moreover, susceptibility of date fruits to these pathogens may be due to the presence of suitable nutritional values in date fruits. In this case, the studied organisms are not likely to be the true pathogen, but rather responsible for causing post-harvest spoilage.

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