



AQUAPONIC SECTION

Taste testing bitter gourd (*Momordica charantia*) grown in Aquaponics

Mohammed Khandaker and Benz Kotzen

School of Design, University of Greenwich, Park Row, London, SE10 9BD, United Kingdom

E-mail addresses: m.khandaker@gre.ac.uk and b.kotzen@gre.ac.uk

Abstract – Bitter gourd which is imported into the UK from abroad has been shown to be suitable to be grown in aquaponics under greenhouse conditions. Whilst research has indicated the plant grows well under greenhouse aquaponics conditions, as yet there has been no research on taste qualities. The aim of the study was thus to ascertain whether the taste of aquaponically grown bitter gourd is better or at least comparable with market-bought bitter gourd, grown abroad. Six adult participants participated in a blind taste test of 3 recipes of both aquaponically-grown bitter gourd and market-bought bitter gourd. The tests have shown that aquaponically grown bitter gourd is better and preferred in taste to the imported bitter gourd not grown aquaponically.

Keywords – Aquaponics, bitter gourd, taste test, Asian vegetables

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Introduction

Bitter gourd (*Momordica charantia*) or bitter melon or balsam pear has been cultivated within an aquaponics system to investigate the potential for growing Asian exotic vegetables in greenhouse aquaponic systems in the UK. The reason to grow these exotic vegetables is to provide more sustainable produce locally, thus reducing the carbon footprint / food miles of these products which are imported from abroad. Bitter gourd is used mainly as a vegetable in Asian cooking and can be found in many Chinese, Bangladeshi, Indian etc. recipes. It is mainly imported into the UK where it can be purchased fresh in markets and supermarkets. It is also available frozen. The fruit is also used in health drinks and can be bought in capsule form as 'bitter melon' from health food shops.

Bitter gourd is a cucurbit and it is now widely cultivated for the immature fruits and sometimes for the tender leafy shoots for cooking or the ripe fruits, for seeds (Cantwell et al, 1996). Bitter gourd is a monoecious creeper and it is described as a popular and widely cultivated nutritious and delicious vegetable grown mostly in tropical parts of Asia (Mia et al., 2014; Behera et al., 2011) and all over Bangladesh. Apart from Asia, it is cultivated mainly in tropical areas of the Amazon basin, Africa, the Caribbean

and South America (Wang et al, 2007). The fruits, leaves and roots of bitter gourd have also been used to treat a number of diseases where the plant is used to create anthelmintic drugs (against parasites), laxatives and a bitter stomachic which improves stomach function (Mia et al. 2014., Din et al., 2011, Hossain et al, 2006; Shetty et al., 2005). The juice from the fruit is also used to treat diseases of the spleen, liver, rheumatism and gout (Mia et al, 2014). The therapeutic effects of bitter gourd is due to its content of bioactive compounds (Tan et al, 2016). Different pre-clinical efficacy studies demonstrated the potential of bitter gourd to target obesity/type II diabetes-associated metabolic aberrations and it has anti-cancer efficacy against various malignancies (Raina et al, 2016).

The research undertaken over a 3 year period has indicated that bitter gourd grew extremely well in the conditions provided on the rooftop Aquaponics Laboratory greenhouse at the University of Greenwich. As part of the research process, nutritional testing was undertaken by XRF analysis (X-ray fluorescence, which determines the elemental composition of materials) at ZHAW (Zurich University of Applied Sciences) and moisture and CHNO (carbon, hydrogen, nitrogen and oxygen) analysis was undertaken at the University of

Greenwich. The results of the tests indicate that the aquaponically grown fruit had more moisture, and a higher salt content than market bought specimens.

Additionally, a series of taste tests was undertaken, during July 2018, in order to ascertain any differences between the bought produce and the aquaponically grown produce and to determine whether the aquaponically grown produce was as good as, if not better than the bought produce.

The research asks the following questions:

1. Does aquaponically grown bitter melon taste the same as traditionally grown bitter melon that is bought on the market?
2. Is the quality on consumption of aquaponically grown bitter melon the same as traditionally grown bitter melon?

In order to answer these questions taste tests were conducted where aquaponically grown bitter melon was compared to market bought bitter melon which were cooked in a number of dishes and then taste tested by staff members at the University of Greenwich.

Materials and methods

Bitter melon plants and fruit were grown in the Aquaponics Laboratory at the University of Greenwich. Then these bitter melons were compared with the bitter melons, imported from Italy, bought from a stall at the Christ Street Market in East London.

Six adult participants participated in a blind taste test of both the aquaponically grown bitter melon and the market-bought bitter melon which were cooked using 3 different dishes (1 Chinese and 2 Bangladeshi). The testing occurred on 11 and 27 July 2018. The participants on 11 July (Chinese recipe) were all women and ethnically English/European and on the 27th the participants were 3 males and 3 females of the same background. The age range of the participants was from 25 to 60. All of the participants in the tests had never previously tasted bitter melon. The cooks cooked both the recipes using either the aquaponically grown fruit and the market bought fruit using the same ingredients, according to the same weights and measures and the same cooking times. (The recipes are available from the authors.)

Recipe 1 was a Chinese bitter melon stir fry with eggs. Recipe 2 was an East Asian bitter melon stir fry and Recipe 3 comprised bitter melon with lentils (see recipes in Appendix). The bitter melon samples were served with rice and wheat tortillas. The participants were provided with a set questionnaire (see Appendix). The test comprised 6 questions with yes/no answers as follows:

- Can you see any visual difference between the two samples A and B?
- Can you smell any difference?
- Can you taste any difference?

- Can you notice any difference in texture? with an option to provide comments.

The preference test also included using a Hedonic scale (Lawless & Heymann, 1998) from '0 to 5'. The question asked was 'If you have a preference how much better is the one compared to the other?'. The Hedonic scale hierarchy was as follows:

- 5-Very much better;
- 4-Much better,
- 3-Moderately better,
- 2- Better,
- 1- Slightly better,
- 0-They are the same.



Figure 1. Bitter melon grown in the aquaponics system harvested at optimum size after approximately 1 month from fertilization, (top photo) and market bought (bottom photo).

Results

The results of the taste test are as follows:

Visual difference

Recipe 1: Fifty percent of the participants did not find any visual difference with the cooked bitter melon whereas the other 50% did find a difference in visual appearance. The differences they found was that aquaponically grown bitter melon was more vibrant and greener than the bought bitter melon. One participant,

however, noted that the bought bitter gourd was fleshier than the aquaponics one.

Recipe 2: Fifty percent of the participants did not find any visual difference with the cooked bitter gourd whereas the other 50% did find a difference in visual appearance. One participant (17%) identified a reddish colour in the aquaponically grown bitter gourd.

Recipe 3: Eighty three percent of the participants observed a visual difference with the cooked bitter gourd. This was not described, however one person noted that the aquaponically grown bitter gourd appeared to have more skin. One person (17% of the participants), did not find any visual variation.

Differences in smell

Recipe 1: Three of the six participants (50%) identified a variation in smell whereas the other (50%) could not identify any difference. One of the participants found the aquaponically grown bitter gourd to smell more 'flavoursome' whilst another found the bought grown bitter gourd to have a stronger smell. One participant noted that both recipes smelled good but the aquaponically grown recipe smelled even 'nicer'.

Recipe 2: Eighty three percent (5 participants) could not differentiate between the market bought and aquaponically grown bitter gourd whereas one participant (17%) found a difference in smell, finding the aquaponically grown bitter gourd to have a stronger smell.

Recipe 3: Eighty three percent (5 participants) did not find any difference in smell whereas one (17%) participant found a stronger smell with the aquaponics recipe.

Taste difference

Recipe 1: All of the participants found a difference in taste and 50% noted that the market bought bitter gourd was more bitter and one person (17%) noted that the aquaponics grown bitter gourd had more flavour.

Recipe 2: All of the participants found a difference in taste between the two samples. However no comments were added.

Recipe 3: All of the participants also found a difference between the aquaponically grown bitter gourd and the market bought bitter gourd.

Difference in texture

Recipe 1: Amongst the six participants, four participants responded to the questions of whether they can identify any difference in the texture between the two samples. Amongst the participants 75% could not identify any difference in texture and 25% did identify a difference. One person noted that the market bought bitter gourd was 'meatier'.

Recipe 2: Sixty-seven percent of the participants (4 of the participants) did not find any difference in texture between the market bought and aquaponically grown bitter gourd whereas 33% of the participants (2 of the participants) could identify a difference in texture of the bitter gourd, but without any additional comments.

Recipe 3: Similarly in recipe 3, sixty seven percent of the participants were unable to identify the difference in texture and 33%, (2 of the participants) observed a variation in texture.

Preference based on all taste test criteria

Recipe 1: All six participants preferred the aquaponically grown bitter gourd over the market bought bitter gourd.

Recipe 2: All six participants preferred the aquaponically grown over the market bought bitter gourd.

Recipe 3: Four out of the six (67%) of the participants preferred the aquaponically grown bitter gourd to the market bought produce.

Hedonic test: The scale of preference

Recipe 1: (See Figure 2). The test showed a variation in the preference for the aquaponically grown bitter gourd from being 'slightly better' to being 'very much better'. The overall result from the 3 tests indicates that most people preferred the recipes with the aquaponically grown bitter gourd.

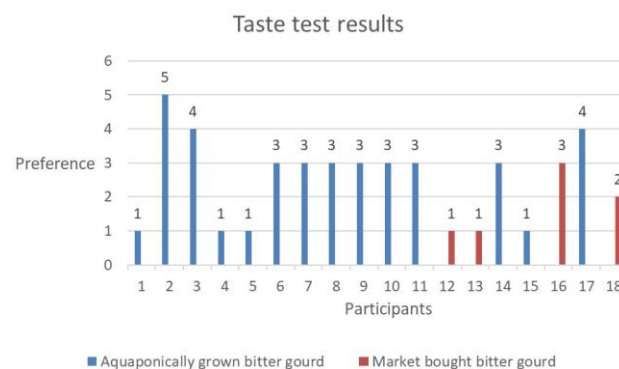


Figure 2: Graph of the results of the taste preference of aquaponically grown vs. market bought bitter gourd over 3 recipes with 18 participants.

Discussion

The results from the taste test indicated the preference of aquaponically grown bitter gourd over the market bought bitter gourd. There are a few reasons for this preference as follows:

Visually the aquaponically grown bitter gourd looked greener and brighter in colour as it was just harvested and taken immediately for cooking, whereas the market bought one was most likely transported for a time after

harvest until being displayed in the market. It is likely that the market bought bitter gourd lost some of its water content after harvest and this meant that there were slight visual differences and differences in taste, smell and texture. The market bought bitter gourd tasted more bitter compared to the aquaponically grown bitter gourd because with a loss of moisture the bitter compounds became more concentrated and thus there are more of these compounds per weight of the bitter gourd. Thus in each mouthful of bitter gourd there will be more concentrated bitterness. Bartoshuk and Klee (2013) note as well that agricultural and postharvest practices contribute to poor flavour.

Limitations

Whilst every effort was made to ensure that the recipes used exactly the same amounts of produce and that the home grown versus the market bought produce were similar (like for like), except in origin, there were some differences. Whilst the aquaponically grown produce was fresh, the age of the bought bitter gourds from the market was not established as the market owners would not provide this information. It is presumed that they were at least a few days old. The size of the fruit also differed between the aquaponically grown and market bought. The aquaponically grown fruit was significantly larger and wider. Whilst the participants on the whole preferred the aquaponically grown bitter gourd, especially the taste, the participants were all from a European origin and someone from South East Asia may find that increased bitterness is preferable and thus they may have preferred the older, more desiccated, store bought bitter gourd.

Conclusions

Bitter gourd has been growing very well in the aquaponics system under greenhouse conditions and the evidence is clear that there is potential for growing bitter gourd fruits locally rather than importing them. The taste tests indicated that the aquaponically grown bitter gourd is preferred and better or at least comparable on the whole and most importantly, in taste to the traditionally grown and imported bitter gourd. The production of bitter gourd in greenhouse aquaponics systems thus shows real promise, from the point of view of production but also in terms of quality as the taste test research shows that when cooked it is preferred.

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