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DEVELOPMENT AND SENSORY EVALUATION OF AN IMPROVED BEVERAGE FROM NIGERIA'S TAMARIND (*Tamarindus indica* L.) FRUIT

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ABSTRACT

Tamarind (*Tamarindus indica* L.), an indigenous underutilised tree fruit, has many valuable properties and almost every part of the tree is utilised by rural and urban dwellers. Nigerian tamarind fruits are grossly underutilised, with the rural dwellers utilising some of the fruits in beverage production using ancient processing methods. The ancient processes of manufacture are cumbersome, slow, non-hygienic and highly subjective, often resulting in non-uniform and low quality products which are less preferred to commercial imported ones. Furthermore, traditional tamarind beverage is not as popular among the populace as other traditional beverages. There is therefore a need to develop simple and affordable process of producing standard tamarind beverage which would be widely accepted by Nigerians. A simple, improved processing method was developed based on the traditional method of manufacturing tamarind beverage using the modified one-factor-at-a-time method to determine the experimental levels of the various ingredients used in the formulation of the beverage. A pilot study was carried out to determine the acceptable range of pulp to water blend. The beverages were evaluated by the paired preference, hedonic rating and multiple comparison tests using 50 semi-trained assessors within the age range of 18 and 45 years. The results of the paired preference tests were expressed as levels of significance while the mean scores of hedonic rating tests were subjected to analysis of variance. Tukey's test was used to separate the means. Samples of tamarind beverages produced by the traditional and improved processing methods were analysed for colour, pH, total acidity, soluble solids, ascorbic acid, total solids, browning index and cloudiness using standard methods. The colour (A_{325nm}), cloudiness (A_{660nm}), browning index (A_{420nm}) and ascorbic acid (mg/100ml) of the traditional and improved beverages were 0.91±0.25, 0.68±0.16, 1.42±0.04, 9.5±0.69 and 0.60±0.01, 0.13±0.01, 0.19±0.01 and 10.4±0.21, respectively. While the traditional processing method took 10 hours to produce about 10 litres of beverage, the improved processing method took 2 hours to produce 250 litres of beverage. The improved beverage was rated much higher in terms of colour, aroma, taste and overall acceptability than the traditional beverage and compared favourably well with a similar commercial beverage. A beverage with more acceptable qualities than the traditional beverage was thus produced from the improved processing method.

Key words: tamarind, Nigeria, beverage, colour, processing

INTRODUCTION

Tropical tree fruits are important in the supplementation and improvement of diets [1]. The tropical forest and its adjoining savannah zone are rich in wild tree fruits, many of which are neither cultivated nor eaten in the zone [2]. These lesser-known food plants are extremely rich in food value while some have unusual tastes, not known among the cultivated species [2, 3, 4, 5, 6, 7]. The potential of indigenous tropical tree fruits has not been fully realised [1].

Tamarind (*Tamarindus indica* L.), an indigenous underutilised tree fruit, has many valuable properties and almost every part of the tree is utilised by rural and urban dwellers [1]. In Nigeria, tamarind fruit is usually consumed fresh and the seed discarded. Tamarind pulp has a unique sour taste due to the natural occurrence of sugars and plant acids together [8]. The rural dwellers utilise the pulp in beverage production, using ancient processing techniques. The traditional processing methods are cumbersome, slow, non-hygienic and highly subjective, often resulting in non-uniform products whose acceptability is restricted to certain parts of the country. Tamarind is underutilised because inadequate research efforts are directed on it [1]. Furthermore, low cost processing techniques are essential for increased exploitation of tamarind [1].

There is an increase in the demand for juice and juice type beverages [9], resulting in increased fortunes of leading beverage manufacturers. Most of the available beverages in Nigerian markets are either imported or produced under franchise agreement with foreign-based multi-national companies. The multi-nationals own rights to formulae and trademarks, and supply semi-finished products with instructions to indigenous bottlers who merely install the plant, produce according to specifications and market the products [10, 11, 12]. Large percentage of the profit in the lucrative beverage industry thus accrues to foreign partners. Research efforts should therefore be intensified to develop simple and affordable processes to produce standard beverages from indigenous resources, especially underutilised tree fruits like tamarind.

There is a reawakening of interest among Nigerians in the consumption of traditional non-alcoholic beverages [13, 14, 15]. Traditional non-alcoholic beverages play vital roles in the lives of Nigerians as they are consumed for their thirst-quenching properties, stimulating effects and for ceremonial rites [16, 17, 18]. Many types of traditional beverages are available in Nigeria but only a few like *kunun-zaki*, *braga*, *soborodo* are popular among the populace. Tamarind beverage is among those beverages which are yet to be widely accepted in Nigeria. Tamarind beverage, like most other traditional beverages, emanated from the northern parts of Nigeria and its traditional processing method is not standardised, thereby resulting in inconsistent product quality with low acceptability among the Nigerian populace. Little or no attempt has been made to improve both the quality attributes and processing method of tamarind beverage in order to make it popular in the southern parts of Nigeria. Wine was produced from various extracts of tamarind pulp, using traditional processing method [19]. Onuorah and collaborators [20], on the other hand, reported

on an improved processing method for tamarind beverage but did not give any information on the sensory qualities and other important chemical properties, apart from pH and total solids, of the products. Upgrading the quality attributes of tamarind beverage, using an improved processing method may be able to diversify the beverage market and provide a totally new experience for consumers, especially in the southern parts of Nigeria where traditional beverage consumption is low compared with the consumption of imported beverages and/or locally reconstituted concentrates. This study therefore developed an improved process, which is simple and affordable, for the production of juice type beverage, with improved quality attributes, from tamarind fruits.

MATERIALS AND METHODS

Raw Materials

Mature tamarind (*Tamarindus indica* L.) fruits were obtained from Shaki in Oyo State, Nigeria. Clove (*Syzgium aromaticum* L.), ginger (*Zingiber officinale*), pepper (*Capsicum annum*) and granulated sugar were procured from Akesan market in Oyo town, Nigeria.

Traditional processing method of tamarind beverage

Tamarind beverage was prepared by the traditional method outlined in Fig. 1. About 28 g fruits were steeped in two litres of water for 6-8 hrs and the pulp separated from the seeds manually by scrubbing. The mixture was sieved with muslin cloth to separate the extract from seeds and other foreign materials. Spices (ginger, clove and pepper) which had earlier been ground in a pestle and mortar were thereafter added to the extract. About 1 - 1.5 litres of water was further added to the extract before heating in an open pot for about 40 minutes. About 300-350 grams of sugar was added to the beverage after about 20 minutes of heating in an open pot placed over fire wood. The beverage was further heated for about 10 minutes, removed from the heater, allowed to cool and packaged in unsterilised recycled polyethylene bottles.

Improved processing method of tamarind beverage

The one-factor-at-a-time method of Omobuwajo [11] was modified to determine the quantities of the various ingredients to be used in the formulation of the improved tamarind beverage.

A pilot study was carried out to determine the acceptable range of pulp to water blend. The seven treatments (1 g: 600 ml, 1 g: 700 ml, 1 g: 750 ml, 1 g: 800 ml, 1 g: 850 ml, 1 g: 900 ml, 1 g: 1000 ml of pulp to water, respectively) selected from the pilot study were subjected to paired preference test. The test revealed that as the dilution ratio increased above 1 g: 750 ml, there was a decline in preference. The most preferred blend (1g in 750 ml) was then mixed with various quantities of sugar (24-30 g) and subjected to paired preference test in order to determine the most acceptable level of sugar. The sample containing sugar at 27.5 g level was most preferred. Seven experimental blends of tamarind beverages (Table 1) were formulated to determine the most acceptable combination of spices (ginger, clove and pepper) with sugar, and

subjected to paired preference and hedonic rating tests. The beverages were pasteurised at 95^{o}C for 3-10 min and were also subjected to paired preference test.
The improved tamarind beverage was thus prepared according to Fig. 2. Tamarind pulp was manually separated from shells, seeds and other foreign materials. 1 g pulp was mixed with 750 ml of water. Spices (ginger 0.6 g, clove 0.4 g) and sugar (27.5 g) were added. The mixture was sieved with four-fold layer muslin cloth. The beverage was packaged in sterilised glass bottles (121^{o}C for 15 minutes), corked and pasteurised (95^{o}C for 8 minutes).

Sensory evaluation
Tamarind beverages were evaluated by the paired preference, hedonic rating and multiple comparison tests using 50 semi-trained assessors within the age range of 18 and 45 years.

The paired preference test was used to determine which, if any, of a pair of treatments was preferred when compared with each other. At each testing session, two samples were presented simultaneously to the assessors who were asked to state, which of the two samples was preferred. The assessors were asked to so indicate if both samples were liked equally. The number of pairs was determined by the formula ½ n(n-1) where n = number of samples or treatments. Hedonic rating test was done using a scale where 9 = like extremely, 5 = neither like nor dislike, 1 = dislike extremely [21]. Properly coded samples were used and the order of presentation was randomised to eliminate the effect of sample sequence on food preference. The beverages were evaluated for colour, taste, aroma and overall acceptability. In the multiple comparison test, a commercial beverage (ginger drink), tagged R, was used as a reference against which the assessors were asked to compare the colour, taste, aroma and overall acceptability of tamarind beverages on a 9-point hedonic scale where 1 = extremely inferior to R, 5 = equal to R, and 9 = extremely superior to R [20].

Chemical analyses
Samples of tamarind beverages produced by traditional and improved processing methods were analysed for colour, pH, total acidity, soluble solids, ascorbic acid, total solids, browning index and cloudiness using standard methods [13, 22, 23, 24].

Statistical analyses
The results of the paired preference tests were expressed as levels of significance [25]. When considering the results from the paired preference test, the statistical significance of the data was determined by excluding the 'no' preference responses and calculating significance on the total number of assessors who expressed positive preference. This follows recommendations for evaluating paired preference data [26]. Scores of hedonic rating tests were averaged to obtain mean scores which were subjected to analysis of variance. Tukey's test was then used to separate the means. Data obtained for other quality attributes of the beverage were analysed using analysis of variance and Duncan's multiple range test.

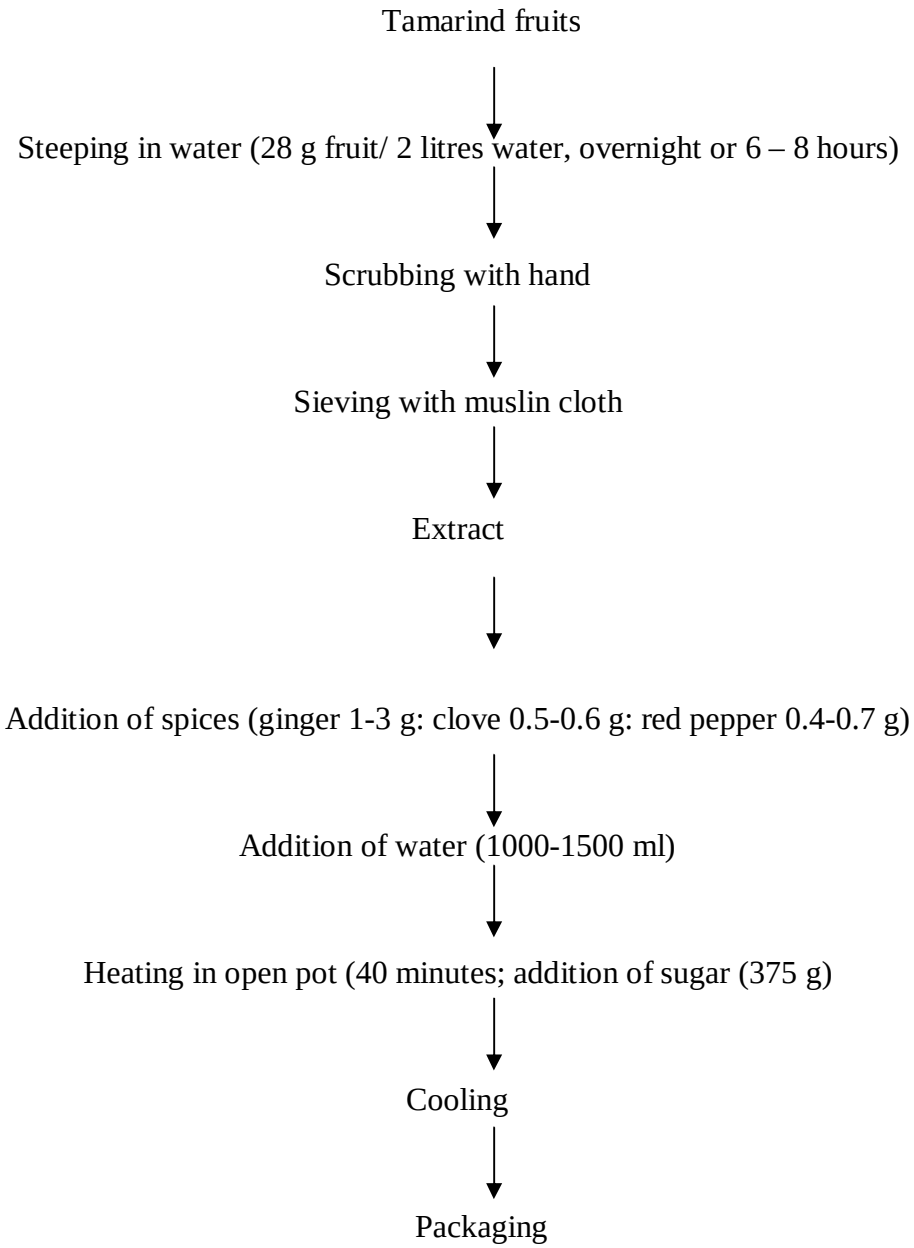

Figure 1: **Traditional processing method of tamarind beverage**

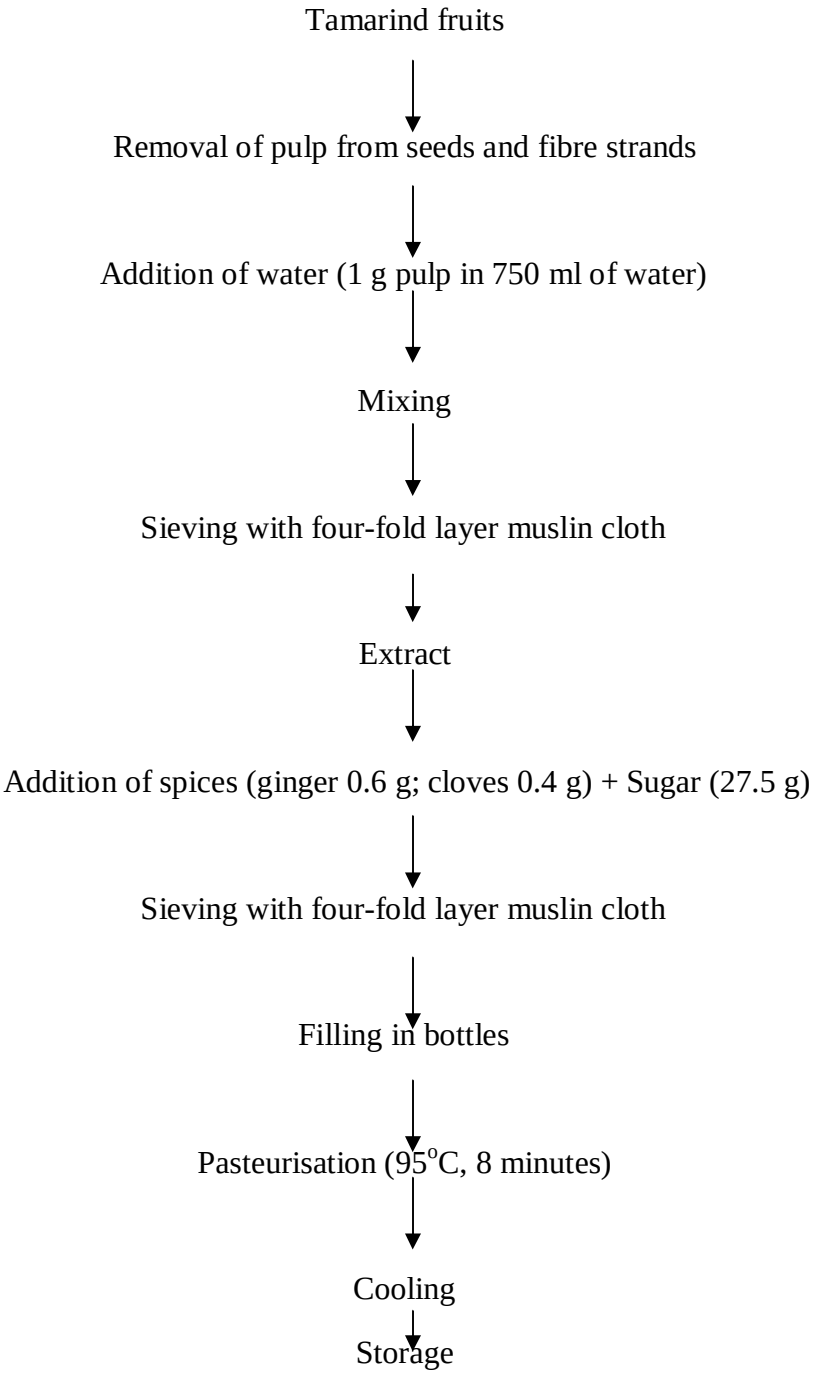

Figure 2: Improved processing method of tamarind beverage

RESULTS

Table 2 shows the chemical attributes of tamarind beverages produced by the traditional and improved processing methods. The colour, measured as optical density at 325nm, was 0.91±0.25 and 0.60±0.01 for traditional and improved beverages, respectively. The total solids (g/100ml) and soluble solids (^{o}Brix) contents of the traditional beverage were 19.8±0.94 and 19.5±0.51 respectively. The improved beverage, on the other hand, had total solids (g/100ml) and soluble solids (^{o}Brix) contents of 10.8±0.32 and 10.1±0.12. The improved tamarind beverage was less acidic (pH 3.4; total acidity 0.7 %) than the traditional beverage (pH 2.8; total acidity 1 %). Significant differences ($p<0.05$) were observed in cloudiness and browning indices of the two beverages. The ascorbic acid (mg/100ml) value was higher in improved beverage (10.4±0.21) than the traditional beverage (9.5±0.69). Table 3 shows the sensory qualities of the improved beverage when compared with the traditional beverage and a similar commercial product. Significant differences were observed in all the sensory attributes of the beverages, with the traditional beverage recording the lowest values. The improved beverage compared favourably with the reference sample. The improved beverage was the most preferred with respect to colour, aroma, taste and overall acceptability.

DISCUSSION

The traditional processing method of tamarind beverage (Fig. 1) is highly subjective, varying from time to time, and from one producer to another. This inconsistency often results in non-uniform products whose quality attributes are inferior to other commercial beverages. However, the ingredients and processing method are standardised in the improved processing method (Fig. 2). The practice of soaking tamarind fruits for 6-8 hours and heating the beverage for forty minutes in an open pot may adversely affect the quality attributes of the tamarind beverage and prolong the processing time. Soaking, for example, may encourage fermentation, which is undesirable in a non-alcoholic beverage, by the microflora of the raw materials and utensils used in traditional processing method while heating may cause the beverage to acquire burned flavours, dark colour and loss of nutritional value. The soaking stage was eliminated in the improved processing method and the prolonged heating in open pot was replaced by pasteurisation, which involves a comparatively low order of heat treatment. In the traditional processing method of tamarind beverage, little attention is given to good hygiene in the selection of processing materials and activities. The use of unsterilised recycled polyethylene bottles in the traditional processing method can encourage the presence of pathogenic or spoilage microorganisms in the beverage. Many non-alcoholic traditional beverages have been reported to contain high microbial counts [13, 15, 20]. The traditional processing method makes use of utensils like cooking iron pot and bowls, wooden rod, fire wood, pestle and mortal while the improved processing method involves the use of simple pasteuriser, plastic bowls, cooking vats, muslin cloth and corking machine. While the traditional processing method takes 10 hours to produce about 10 litres of beverage, the improved processing method takes 2 hours to produce 250 litres of beverage. The

production cost of tamarind beverage from the improved processing method is estimated at ₦15.54 (0.1 USD) while the retail prices of similar manufactured beverages ranged from ₦50.00 (0.34 USD) and ₦80.00 (0.54 USD). Hence, the improved tamarind beverage is considerably cheaper than other similar manufactured beverage.

The significantly ($p<0.05$) wide differences in the quality attributes of the traditional and improved tamarind beverages (Table 2) may be attributable to the different processing methods employed. Processing methods have been reported to have great influence on the quality attributes of beverages [11, 12, 15, 27, 28, 29, 30, 31]. The high total solids recorded for the traditional beverage may be attributed to the increased sugar addition owing to its high sourness requiring more sweetner than the improved beverage which is less sour. Furthermore, the low sugar content of the improved beverage is in line with the recommendations of WHO/FAO [32] expert consultation on diet, nutrition and the prevention of chronic diseases that levels of sugar, trans fatty acids, saturated fatty acids, sodium in manufactured food products are reduced. The acid content of tamarind beverage is desirable from food processing standpoint, since acidity is important in determining the quality of fruit juices [33]. Acidity contributes to the development of flavour by maintaining a proper sugar - acid ratio thereby modifying the sweetness of sugar and palatability of food products, lends tartness to taste and also provides a thirst-quenching effect by encouraging saliva formation in the mouth [12, 33]. Acidity also increases the efficiency of heat processing and inhibits the growth of surviving heat resistant microorganisms [34].
The improved processing method resulted in an improvement in the colour and ascorbic acid contents of beverages, probably due to the less severe effect of pasteurisation on these quality attributes since carotenoids- β- carotene and lycopene in tamarind pulp could have decomposed to affect the colour of beverage during heating in the traditional processing method. Pasteurisation temperature of 90^{o}C assured pectinesterase inactivation without detectable changes in flavour and colour of tamarind nectar and puree [35]. Furthermore, mild heat improved the colour of carrot juice [29]. The inactivation of pectinesterase may have resulted in the decrease in the value of cloudiness of the beverage produced by the improved processing method when compared with the traditional processing method. Browning was more pronounced in the beverage produced by the traditional processing method than that of improved processing method, probably due to the higher total solids, total soluble solids and sugar in the traditional beverage. Browning in the beverages could have been due to Maillard-type reactions resulting from the presence of reducing sugars, proteins and amino acids. Table 3 further shows that the improved tamarind beverage compared well with a similar commercial product obtained from the market.

CONCLUSION

The traditional method of processing tamarind beverage is laborious, crude, non-hygienic and not standardised, with the levels of the ingredients not quantified. A simple and improved processing method that is economically and technically viable for the manufacture of a tamarind beverage was developed. The beverage produced by

the improved processing method at a cost of ₦15.54 for a 500 ml bottle has more acceptable quality attributes than the one from the traditional processing method and is considerably cheaper than similar products from conventional sources.

Table 1: Formulation of experimental blends of tamarind beverages

Ingredients	Experimental blends of tamarind beverages						
	A	B	C	D	E	F	G
Ginger	0.6	0.6	0.6	-	0.6	-	-
Clove (g)	0.4	0.4	-	0.4	-	0.4	-
Pepper (g)	0.3	-	0.3	0.3	-	-	0.3
Water (l)	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Sugar (g)	27.5	27.5	27.5	27.5	27.5	27.5	27.5
Tamarind (g)	10	10	10	10	10	10	10

Table 2: Quality attributes of tamarind beverage prepared by traditional processing method

Attributes	Traditional	Improved
Colour (A_{325nm})	0.91±0.25	0.60±0.01
Total solids (g/100ml)	19.8±0.94	10.8±0.32
Soluble solids (^{o}Brix)	19.5±0.51	10.1±0.12
pH	2.8±0.50	3.4±0.10
Total acidity (%)	1.0±0.17	0.7±0.06
Cloudiness (A_{660nm})	0.68±0.16	0.13±0.01
Browning index (A_{420nm})	1.42±0.04	0.19±0.01
Ascorbic acid (mg/100ml)	9.5±0.69	10.4±0.21
Total sugar (%)	17.9±0.43	10.1±0.21
Ash (%)	0.43±0.05	0.23±0.06

Each result expresses the mean ± SD

Table 3: Mean sensory scores for multiple comparison test

Beverage type	Colour	Aroma	Taste	Overall acceptability
Traditional tamarind beverage	2.2^{a}	3.6^{a}	2.3^{a}	2.9^{a}
Improved tamarind beverage	5.8^{b}	5.9^{b}	4.5^{b}	5.5^{b}
Reference	5.0^{c}	5.0^{c}	5.0^{c}	5.0^{c}
LSD	0.18	0.22	0.22	0.18

Means in the same column with same letters are not significantly different at 5% level

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