

# Effect of Different Concentrations of Coconut Milk on the Chemical and Sensory Properties of Soy-coconut Milk Based Yoghurt

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**Abstract** The possibility of enhancing the sensory attributes of soy yoghurt through the use of composite soymilk was investigated. The effect of using starter cultures from different sources on the chemical characteristics and consumer acceptability was also studied. Soy milk containing 0, 10 and 20% coconut milk were used in the production of soy yoghurt using commercially available yoghurt starter and starters isolated from naturally fermenting soy milk and cow milk. Chemical and sensory characteristics of soy yoghurts obtained were evaluated. The pH of the yoghurt premixes at the beginning of fermentation ranged between 6.25 and 6.45; after fermentation the values were between 4.81 and 5.51 with commercially available starter bringing about greatest pH reduction. Chemical compositions of obtained soy yoghurts were as follows: titratable acidity as %lactic acid (0.25-0.43%), crude protein (2.66-3.62%), fat content (0.13-0.89%), total solid content (7.91-9.06%). Variation in premix formulation had no significant ( $P>0.05$ ) effect on the chemical composition of different soy yoghurts obtained. Addition of coconut milk to soy milk improved the sensory characteristics of soy yoghurts with the premix containing 10% coconut milk fermented with starter obtained from cow milk producing yoghurts with the best taste, aroma, and acceptability. Results from the present study have demonstrated a further way of enhancing soy yoghurt acceptability by the western 'palate'.

**Keywords** Soy Milk, Coconut Milk, Soy Yoghurt, Yoghurt Starter

## 1. Introduction

The continuous increase in population and inadequate supply of protein has inadvertently increased the occurrence of malnutrition in developing countries[1]. However, in order to meet the protein demands in developing countries, where animal protein is also grossly inadequate and relatively expensive, research effort is geared towards finding alternative sources of protein from legume seeds[2].

While describing the precarious state of food supply in the developing countries, Ene-Obong[3] posited that milk and its products are hardly major items of diet in developing countries. However, it must be stressed that for the selective few that are able to afford animal milk, there is always an increasing concern about its fat and cholesterol contents. This factor has made vegetable milk to become an alternative source of milk. In this regard, soymilk has been recognized as being nutritionally helpful. For instance, Murti *et al.*[4] stated that soy yoghurt (a product from soymilk) accords advantages in terms of nutrition and health, since it contains

no cholesterol or lactose and only small quantities of saturated fatty acids; in addition to its advantage of low cost.

Many soy products have limited human use in the Western hemisphere due to undesirable off-flavours[5,6]. Lactic acid fermentation has been reported as a means of reducing beany flavours and anti-nutritional factors in soybean products, and with the addition of sweeteners it is possible to obtain products with better acceptance by panelists[6,7]. Report has also indicated that soy yoghurt acceptability could be enhanced by the addition of various flavourants and fruit flavours[8].

In the recent past, soy yoghurt has been put in the same class as cow milk based yogurt. Consequently, the regular yoghurt starters are being employed in soy yoghurt production. However, documented information indicates that soy milk has a significant amount of raffinose and stachyose[9] and that lactic acid bacteria (LAB) from different sources are quite different in their efficiencies in soy yoghurt fermentation[10]. This overlooked aspect of soy yoghurt fermentation might have been responsible for the non production of butter milk like aroma in soy yoghurt obtained through conventional yoghurt starters as noted by Nsofor *et al.*[11].

There are hundreds of ways of using both young tender and mature coconuts as food and useful source of raw materials. Malolo *et al.*[12] reported that the meat of coconut can also be used in preparation of fermented dishes and coconut

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sauce or seasonings for vegetables and root crops, or cooked with other root crops to enhance flavour.

The objective of the present study was to explore the possibility of enhancing the sensory attributes of soy yoghurt obtained from composite milk comprising soymilk and coconut milk. The effect of using different yoghurt starters on its chemical composition and acceptability was also investigated.

## 2. Materials and Methods

### 2.1. Materials

Fresh cow milk was purchased from nomads at Bodija Market, Ibadan, Nigeria. It was transferred in a sterile container to the laboratory for the isolation of LAB. Soybean seeds (variety TGX-923-2E) were obtained from the Institute of Agricultural Research and Training, Moor Plantation, Ibadan, Nigeria. Commercially available yoghurt starters and other ingredients were purchased from local stores.

### 2.2. Methods

#### 2.2.1. Production of Soy Milk and Coconut Milk

The method of Mital *et al.* as reported by Lee *et al.*[13] was used to produce soy milk. To produce coconut milk, coconut seed was cracked manually and the coconut meat removed with sharp knife. The brown part of the coconut meat was gently scraped off. It was cut into smaller pieces to enhance quicker blending. Two hundred grammes of white coconut meat was blended with 1 litre of distilled water. The slurry obtained was further diluted with 1 litre of distilled water. It was then sieved with double layers of cheese cloth. The filtrate obtained is coconut milk. It was kept inside refrigerator and used within 45 minutes.

#### 2.2.2. Isolation, Characterization and Identification of Yoghurt Starters

Both fresh cowmilk and soymilk were covered and left on the laboratory bench at  $29 \pm 2^\circ\text{C}$  overnight. LAB were isolated from the naturally fermenting milk by serial dilution in 0.1% peptone water and poured into De Mann Rogosa Sharpe (MRS) agar. The isolates were purified by streak plating using the same medium. Morphological characteristics such as cell shape and arrangement were noted. Biochemical and physiological studies such as catalase reaction, oxidase reaction, type of fermentation, production of ammonia from arginine, growth in 4% NaCl and sugar fermentation profiles were determined using standard methods[14,15]. The results obtained from the tests carried out were used to identify the organisms by reference to Bergey's Manual of Systematic Bacteriology[16].

#### 2.2.3. Yoghurt Manufacture

Three soy-based yoghurt premixes were formulated to contain; (a) Soy milk containing 20% coconut milk, (b)

Soymilk containing 10% coconut milk and (c) Soymilk only. The premixes also contained 3% sugar and 0.5% gelatin. Mixtures of premixes, sugar and gelatin were prepared, homogenized and pasteurized as previously described by Collins *et al.*[17]. The mixture was subsequently placed in water bath to cool down to  $43^\circ\text{C}$  prior to inoculation of starter cultures. The cooled mixtures were inoculated with 1% commercial yoghurt culture (50:50 mixture of *Lactobacillus bulgaricus* and *Streptococcus thermophilus*) as described by Lee *et al.*[13]. The preculture of each of the two isolated LAB from soymilk (*Lactobacillus bulgaricus* and *Streptococcus thermophilus*) was prepared; and the mixed culture were inoculated into the second portions of cooled mixture of each of the premixes at 5% final volume as described by Murti *et al.*[4]. The same procedure was repeated for yoghurt started obtained from cowmilk. All the inoculated premixes were poured into plastic cups. They were then incubated at  $43^\circ\text{C}$  and allowed to ferment for 12 hours. After incubation, they were cooled in an ice bath, placed in a cabinet at  $6 \pm 2^\circ\text{C}$  and held for evaluation within 12 hours.

#### 2.2.4. Analyses

Samples were analyzed for proximate composition using standard methods of analyses of AOAC[18]. The pH of the various samples was determined using a pH meter. Acidity was measured as we have described previously[19]. A half milliliter of a 1% solution of phenolphthalein in 95% alcohol was added to ten milliliters of yoghurt sample. Acidity was measured by titrating the mixture thus obtained with 0.1N NaOH; and it was expressed as g equivalent lactic acid/100g. All the determinations were carried out in triplicates and mean values were calculated.

#### 2.2.5. Sensory Evaluation

The yoghurt samples were held at  $6 \pm 2^\circ\text{C}$  until presented for evaluation. A 20-member panel who were regular yoghurt consumers consisted of students and staff of The Polytechnic, Ibadan. Evaluation was done on a nine point hedonic scale. Characteristics evaluated included flavour, colour, taste and overall acceptability.

#### 2.2.6. Statistical Analysis

Data obtained were expressed as means. The statistical significance of differences was assessed using analysis of variance. A two-tailed P value of less than 0.05 was considered to be statistically significant. Values that were significantly different were separated by Duncan Multiple Range test using SPSS for windows Version 11.0 statistical package.

## 3. Result

The characteristics of LAB isolated from naturally fermenting soymilk and cowmilk are tabulated in Table 1. All the isolates were gram positive, catalase negative, indole

negative, oxidase negative and produced acid from glucose and galactose. Some of them fermented raffinose and sorbitol. The majority of them grew in 4% NaCl and at 45°C

while only *Lactobacillus plantarum* grew at 4°C. Substantial portion of these LAB were homofermentative.

**Table 1.** Morphological and Biochemical characteristics of LAB isolates from naturally fermenting cow milk and soy milk

Characteristics	Strains											
	1	2	3	4	5	*6	7	8	9	10	**11	**12
Gram reaction	+	+	+	+	+	+	+	+	+	+	+	+
Shape	R	R	R	C	R	R	R	R	R	R	R	R
Oxidase	-	-	-	-	-	-	-	-	-	-	-	-
Catalase	-	-	-	-	-	-	-	-	-	-	-	-
Indole	-	-	-	-	-	-	-	-	-	-	-	-
Spore staining	-	-	-	-	-	-	-	-	-	-	-	-
Growth in 4% NaCl	+	+	+	-	+	+	+	+	+	+	+	+
Growth at 45°C	+	+	+	+	+	+	+	+	+	+	+	+
Growth at 4°C	-	-	+	-	-	-	-	-	-	-	-	-
H <sub>2</sub> S production	-	-	-	-	-	-	-	-	-	-	-	-
Fermentation type	Hm	Hm	Hm	Ht	Hm	Hm	Hm	Hm	Hm	Ht	Hm	Hm
Glucose	+	+	+	+	+	+	+	+	+	+	+	+
Lactose	+	+	+	+	+	+	+	+	+	+	-	+
Sucrose	+	+	+	+	+	+	+	+	+	+	+	-
Galactose	+	+	+	+	+	+	+	+	+	+	+	-
Maltose	+	+	+	-	+	+	+	+	-	+	+	+
Fructose	+	+	+	+	+	+	+	+	+	+	+	+
Mannitol	-	-	+	+	-	-	-	-	-	-	+	+
Raffinose	-	-	+	+	-	+	-	-	-	-	+	-
Sorbitol	-	-	+	-	-	+	-	-	-	-	+	-
Xylose	-	-	-	-	-	-	-	+	-	-	-	-

Hm= Homofermentative; Ht=Heterofermentative; R=Rod; C=Coccus

\*Isolate from cow milk only; \*\*Isolates from soymilk only

1= *Lactobacillus leichmannii*; 2=*L. casei*; 3= *L. plantarum*; 4=*Streptococcus thermophilus*; 5=*L. acidophilus*; 6=*L. salivarius*; 7=*L. delbrueckii*; 8=*L. xylophilus*; 9=*L. bulgaricus*; 10=*L. fermentum*; 11=*L. coryniformis*; 12=*L. homohiochii*

**Table 2.** Chemical composition of Soy yoghurt samples.

Sample	Acidity	Moisture	Protein NX6.25	Fat	Ash	Carbohydrate	Total Solid
<u>A</u>	0.43 <sup>a</sup>	91.46 <sup>a</sup>	3.03 <sup>bc</sup>	0.30 <sup>c</sup>	0.25 <sup>bc</sup>	4.97 <sup>a</sup>	8.54 <sup>a</sup>
<u>B</u>	0.33 <sup>c</sup>	92.09 <sup>a</sup>	2.66 <sup>c</sup>	0.81 <sup>a</sup>	0.39 <sup>a</sup>	4.05 <sup>cd</sup>	7.91 <sup>a</sup>
<u>C</u>	0.40 <sup>b</sup>	91.48 <sup>a</sup>	2.76 <sup>c</sup>	0.76 <sup>a</sup>	0.28 <sup>b</sup>	4.71 <sup>a</sup>	8.52 <sup>a</sup>
<u>D</u>	0.43 <sup>a</sup>	90.94 <sup>a</sup>	3.25 <sup>b</sup>	0.48 <sup>b</sup>	0.27 <sup>b</sup>	5.05 <sup>a</sup>	9.06 <sup>a</sup>
<u>E</u>	0.30 <sup>d</sup>	91.91 <sup>a</sup>	3.58 <sup>a</sup>	0.68 <sup>a</sup>	0.28 <sup>b</sup>	3.54 <sup>d</sup>	8.09 <sup>a</sup>
<u>F</u>	0.35 <sup>c</sup>	91.89 <sup>a</sup>	2.76 <sup>c</sup>	0.47 <sup>b</sup>	0.39 <sup>a</sup>	4.41 <sup>c</sup>	8.11 <sup>a</sup>
<u>G</u>	0.25 <sup>c</sup>	91.19 <sup>a</sup>	3.09 <sup>b</sup>	0.89 <sup>a</sup>	0.21 <sup>c</sup>	4.61 <sup>b</sup>	8.81 <sup>a</sup>
<u>H</u>	0.25 <sup>c</sup>	91.10 <sup>a</sup>	3.62 <sup>a</sup>	0.13 <sup>c</sup>	0.29 <sup>b</sup>	4.86 <sup>a</sup>	8.90 <sup>a</sup>
<u>I</u>	0.25 <sup>c</sup>	91.58 <sup>a</sup>	3.50 <sup>a</sup>	0.26 <sup>cd</sup>	0.35 <sup>a</sup>	4.30 <sup>c</sup>	8.42 <sup>a</sup>
<u>J</u>	0.33 <sup>c</sup>	91.76 <sup>a</sup>	3.13 <sup>b</sup>	0.23 <sup>d</sup>	0.26 <sup>b</sup>	4.59 <sup>b</sup>	8.24 <sup>a</sup>

Values are means of triplicate determinations. Within column values with different superscripts are statistically significant (P<0.05)

Results are expressed in g/100g sample.

\*expressed as % lactic acid. †calculated by difference

KEY: As in Figure

Figure 1 shows the changes in pH of the fermenting soy yoghurt premixes. The pH of the yoghurt premixes at the beginning of fermentation ranged between 6.25 and 6.45. At the end of 12h of fermentation, the pH values were between 4.81 and 5.51. Results from the present study revealed that commercial starter brought about greater reduction in pH. This was closely followed by starters from cow milk while starters from soymilk brought about the least pH reduction. The reduction in quantity of coconut milk in the yoghurt premixes resulted into greater pH reduction, especially in the soy yoghurts produced by commercial starter culture. However, data from this study depicted that addition of coconut milk three hours into the fermentation process resulted into a lesser pH reduction when compared with the ones added at the onset of soy yoghurt fermentation.

The chemical composition of soy yoghurt samples is shown in Table 3. Titratable acidity (TA) values of soy yoghurts (in terms of % lactic acid) ranged between 0.25 and 0.43%. Crude protein contents were between 2.66 and 3.62% while the fat contents ranged between 0.13 and 0.89%. Total solid content of the soy yoghurts varied between 7.91 and 9.06% while all the yoghurt samples lack crude fibre. It appeared that variability in the formulation of soy yoghurt premixes did not have any significant ( $P>0.05$ ) effect on the chemical compositions of soy yoghurts obtained from different composite soymilks.

The result of the sensory evaluation of the soy yoghurt samples prepared from different yoghurt premixes is shown in Table 4. Result obtained revealed that, addition of coconut milk to soymilk improved the sensory characteristics of the yoghurt obtained from such premixes. However, the yoghurt premix containing 10% coconut milk which was fermented by yoghurt starter isolated from cow milk produced soy yoghurt with the best taste, aroma and overall acceptability. On a general note, it is evident that yoghurt starters from cow milk were possibly the best yoghurt culture in the present study.

## 4. Discussion

Majority of the LAB isolated from the naturally fermenting cowmilk and soymilk belong to the genus *Lactobacillus*. This is in close agreement with the report of Adel Moneim *et al.*[20] who reported that *Lactobacillus* constituted 74% of the LAB associated with *garris* (a Sudanese fermented camel's milk product). This is not surprising as strains of these genera of LAB are known to contaminate raw milk during milking from various sources such as the exterior of the udder, dairy utensils, dust, grass, cattle dung and feed-stuffs[21,22]. Some strains of *Lactobacillus* reported in the present study are similar to those reported in many cultured African dairy products. For instance, Abdel Moneim[23] and Sulma *et al.*[24] reported on the occurrence of *L. fermentum* in Sudanese *robe* and *kisra* respectively. *L. plantarum* was found to be associated with fermented milk in Northern Tanzania and Cameroon[25,26].

The pH values of the soymilk used in soy yoghurt fer-

mentation in the present study compare favourably with the value of 6.6 reported by Favaro *et al.*[27] but lower than 7.2 reported by Osundahunsi *et al.*[8]. Though the pH of all the yoghurt premixes decreased with fermentation time, however, the differences observed in the degree of pH decrease in the fermenting yoghurt premixes might be a reflection of the ability of the yoghurt bacteria to grow in the premixes and ferment the carbohydrates they contained. It is possibly in this background that yoghurt premixes that contained higher quantity of coconut milk underwent least pH change. It has been reported that coconut oil contained some antimicrobial compounds[28]. The addition of coconut milk while the yoghurt fermentation was already in progress may retard acidity development in yoghurt so produced. This might be consequent upon the inhibitory effect of some chemical compounds present in coconut milk on the yoghurt bacteria that were supposedly in the exponential (active) phases of growth.

Davis[29] recommended lactic acid of 0.1% in yoghurt. The value reported in this study is considered to be satisfactory. The lactic acid contents obtained in this study compared favourably with values (0.17-1.16%) reported in the earlier studies[19,30]. Acidity developed in the different soy yoghurts produced depended on the starter culture used and the formulation of the premix used for fermentation. Results from the present study further corroborate the earlier report of Tuitemwong and Tuitemwong[10] who observed that LAB from different sources were different in their efficiencies to ferment soymilk.

The proximate composition of soy yoghurts from the present study is similar to those reported by Favaro *et al.*[27]. Addition of coconut milk to soymilk did not produce any significant changes ( $P>0.05$ ) in the proximate compositions of the soy yoghurt. However, data emanating from the present study depicts that soy yoghurt could be helpful in meeting a significant portion of the daily needs of these nutrients. Reports have shown that consumers' acceptability of soymilk and its fermented product could be enhanced by premix formulation during the production process[8,31]. The result of the sensory evaluation in the present study has shown that soy yoghurt could become acceptable product in the Western hemisphere when appropriate quantity of coconut milk is added to yoghurt premixes.

The world in 2000 pledged through Millennium Development Goals (MDGs 1 and 2) to halve hunger and KEY

A,B&C are yoghurt premixes containing 20% coconut milk and fermented with commercial yoghurt starter, starter from soymilk and starter from cow milk respectively.

D,E&F are yoghurt premixes containing 10% coconut milk and fermented with commercial yoghurt starter, starter from soymilk and starter from cowmilk respectively.

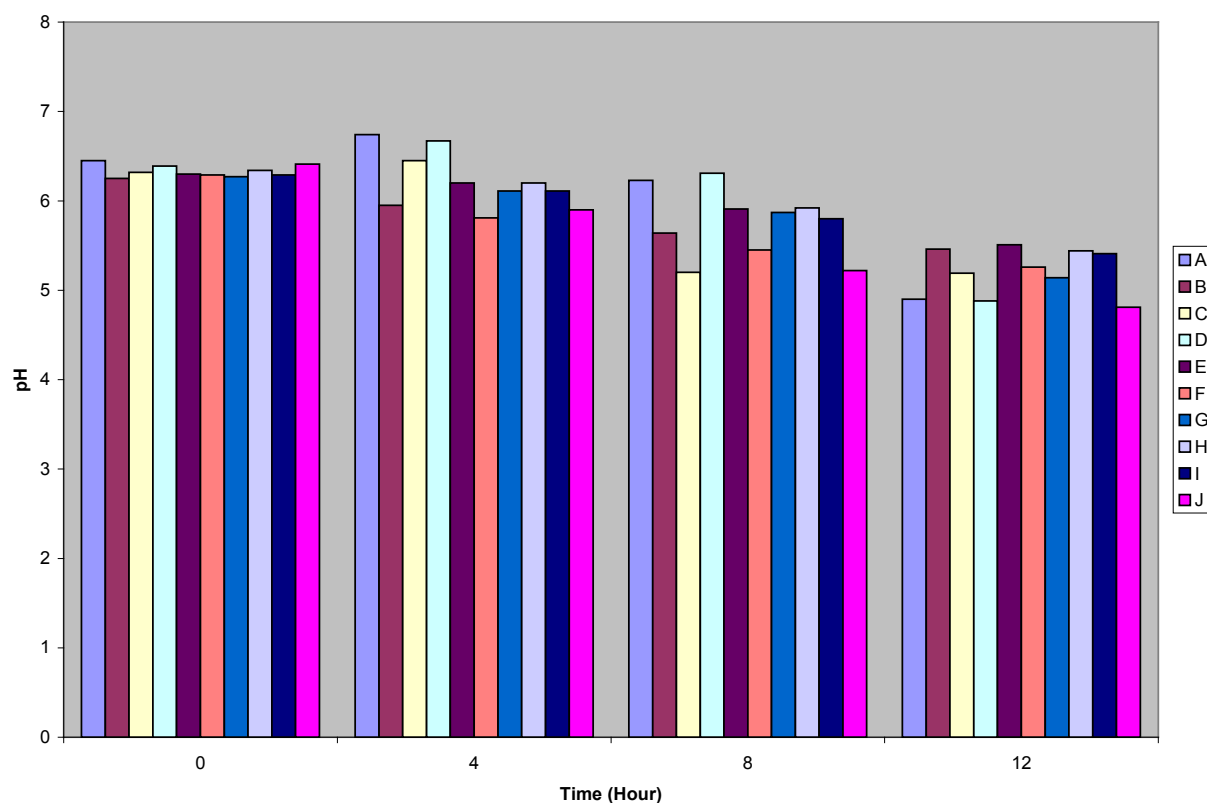
G is a yoghurt premix containing 20% coconut milk and fermented with commercial yoghurt starter with coconut milk added 3hrs after the commencement of fermentation.

H,I&J are yoghurt premixes containing 0% coconut milk and fermented with commercial yoghurt starter, starter from soymilk and starter from cowmilk respectively. ensure uni-

versal primary education by the year 2015. It has since been recognized that school feeding programs could be a key to achieving these goals because they bring many synergies that support each other. As a response, the Federal Government of Nigeria launched a Home-Grown School Feeding and Health Program (HGSF&HP) in 2005[32]. An Indonesian version of the similar program was described by Minarno[33].

Ene-Obong[3], stated that milk and its products hardly feature among the major items of food in developing countries. This is especially critical in the diets of low income

families. Soymilk and its fermented products that could serve as alternative milk is not widely acceptable in the Western hemisphere because of its unpleasant flavour and taste. Results from the present study have demonstrated a further way of enhancing soy yoghurt acceptability by the Western 'palate'. In this regard, adoption of soymilk-coconut milk based yoghurt in the feeding regime of HGSF&HP in Nigeria and other developing countries with similar programs will be helpful in achieving some of the MDGs.



**Figure 1.** pH changes in fermenting soy yoghurt premixes.

**Table 3.** Sensory Evaluation of Soy yoghurt samples.

Samples	Colour	Taste	Aroma	Consistency	Acceptability
A	5.95 <sup>de</sup>	5.85 <sup>bcd</sup>	5.70 <sup>cd</sup>	6.15 <sup>bc</sup>	5.91 <sup>bcd</sup>
B	5.00 <sup>efg</sup>	5.45 <sup>cdef</sup>	5.35 <sup>cd</sup>	5.05 <sup>cd</sup>	5.21 <sup>cde</sup>
C	6.10 <sup>cde</sup>	5.90 <sup>bcd</sup>	5.55 <sup>cd</sup>	5.65 <sup>bcd</sup>	5.80 <sup>bcd</sup>
D	4.15 <sup>g</sup>	4.70 <sup>ef</sup>	4.65 <sup>de</sup>	4.50 <sup>d</sup>	4.50 <sup>de</sup>
E	4.50 <sup>fg</sup>	4.25 <sup>f</sup>	3.85 <sup>e</sup>	4.65 <sup>d</sup>	4.31 <sup>d</sup>
F	6.30 <sup>bcd</sup>	6.60 <sup>ab</sup>	6.00 <sup>ab</sup>	5.45 <sup>bcd</sup>	6.06 <sup>ab</sup>
G	6.20 <sup>cde</sup>	5.10 <sup>def</sup>	5.30 <sup>cd</sup>	5.70 <sup>bcd</sup>	5.60 <sup>bcd</sup>
H	4.30 <sup>g</sup>	4.70 <sup>ef</sup>	4.40 <sup>de</sup>	4.20 <sup>e</sup>	4.40 <sup>de</sup>
I	5.00 <sup>efg</sup>	3.90 <sup>g</sup>	4.50 <sup>de</sup>	4.15 <sup>e</sup>	4.39 <sup>de</sup>
J	6.70 <sup>ab</sup>	5.40 <sup>def</sup>	5.15 <sup>cd</sup>	6.35 <sup>ab</sup>	5.90 <sup>bc</sup>

Within column values with different superscripts are statistically significant ( $P < 0.05$ )

KEY: As in Figure 1

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