Singh, S. R., and H. F. Van Emden, 1979. Insect pests of grain legumes. Annual Review of Entomology 24: 255-78.

Singh, S. R., and D. J. Allen, 1979. Les insectes nuisibles et les maladies du niébé. IITA Ibadan, Nigeria. Manual series n° 2: 113 pp.

Singh, S.R., and D.J. Allen, 1980. Pests, diseases, resistance and protection in cowpeas. Pages 419-443 *in* Advances in Legume Science. Vol. I. Proceedings of the International Legume Conference, Kew, 21 July - 4 Aug 1978, edited by R.J. Summerfield and A.H. Bunting. Kew, UK: Royal Botanic Gardens.

Walangululu, M., K. Songbo, et M. Naku, 1983. Les principaux insectes nuisibles du niébé *(Vigna unguiculata* (L) Walp) à Yangambi. Annales de l'Institut Facultaire de Sciences Agronomiques (Yangambi). 6 (1-2) : 60-65.

Walangululu, M., S. Tabu, et L. Lukoki, 1984. Lutte contre les punaises du niébé *Vigna unguiculata* (L) Walp) à Yangambi (Haut-Zaïre). Etude de l'action de la Basudine et du Dimecron. Revue Zaïroise des Sciences Nucléaires (Kinshasa) 5 (1-2): 67-79.

Walangululu, M., M. Nsitu, et L. Lukoki, 1987. Effets comparés de deux insecticides: le Dimecron et le Méthyl-paraphène sur les punaises du niébé *(Vigna unguiculata* (L) Walp. Scientia (Mbanza-Ngungu). 3 (1): 19-28.

Soymilk Yield and Quality as Affected by Soybean Varieties and Processing Techniques

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Abstract: Grains of nine soybean varieties were processed into soybean milk, and their milk yield and protein (%) were determined, followed by sensory evaluations. In another experiment, grains of five soybean varieties were made into soybean milk, using five different processing techniques. In the first experiment, there was a significant difference among the varieties for milk yield and the sensory evaluation characters, but no significant difference for protein (%). In the second experiment, processing technique, variety, and the processing technique x variety interaction all had a significant effect on milk yield.

Soybeans provide valuable and balanced nutrients at a relatively low price; however, until very recently soybean-based products have not been very popular in Nigeria. A collaborative research project between the International Institute of Tropical Agriculture (IITA) and the Institute for Agricultural Research and Training (IAR&T) has been aiming to popularize soybean utilization in the rural households of Nigeria. This research has resulted in increased production and utilization of soybean.

One of the soybean products now being produced in many homes is soymilk. Soymilk and its by-products offer great potential in helping to alleviate malnutrition. It can also be used by people who are allergic to animal milk (Johnson et al. 1981). Soymilk can be used as a substitute for cow's milk, especially in areas where this product is expensive or unavailable.

Much work has been reported on soymilk processing techniques. Wilkens and Hackler (1969) reported that grinding soybeans in hot water (78°C) greatly improves the flavor of soymilk and that lipoxyginase is inactivated within 10 min when the seed is wet ground at 80-100°C. Nelson et al. (1975, 1976) patented a process (the Illinois process), in which soybeans are blanched before being ground, then soaked in a solution of sodium bicarbonate for 12 h before the hot milk is squeezed.

One of the problems faced by rural households in Nigeria is the nonavailability of sodium bicarbonate, in addition to the burning hazards involved in hot processing.

The overall objective of this work was to look at the effect of different varieties on the yield and quality of soymilk. An additional objective was to establish the effect of the different soybean varieties and processing techniques on soymilk yield and to determine if there is any interaction between variety and processing technique.

Materials and Methods

Nine soybean varieties (50 g) were processed into milk, with a bean to water ratio of 1 : 4 (200 ml water added to each sample), using the standard INTSOY method (Nelson et al. 1976), as outlined in Figure 1.

Protein analysis was determined as N x 6.25, using the Kjeldahl method as described by AOAC (1975), and was conducted on each sample. Five different processing techniques (as outlined in Fig. 1) were then used to process five soybean varieties (TGx 814-36E, TGx 849-294D, TGx 536-02D, TGx 1063-2E, and Samsoy 1) into soymilk. Seeds used for these experiments were of very high grade and were from the seed store of the IITA Grain Legume Improvement Program. None of the seeds had been stored for more than 6 months before use. All processing was carried out on the same day.

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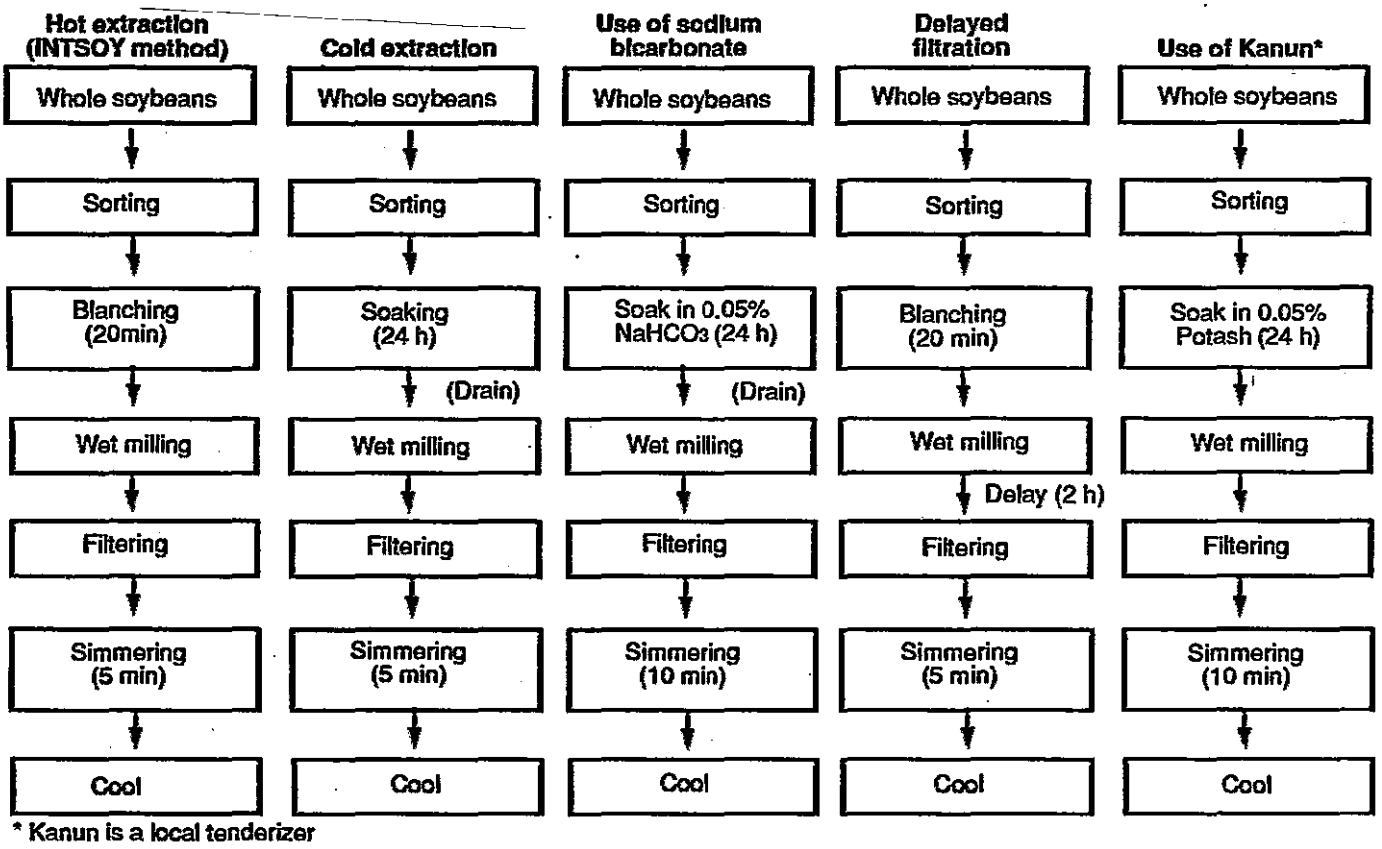

Figure 1. Flow chart of the processing techniques used to obtain soymilk.

A trained 10-member taste panel used a 6-point hedonic scale to evaluate color, flavor, chalkiness, and overall acceptability. The sensory evaluation experiments used a randomized complete block design, with three replicates. Data were subjected to analysis of variance (ANOVA), and parameters, with an F probability of 0.05 or less, were subjected to Duncan's multiple range test, as described by Steel and Torrie (1980).

Results and Discussion

Soymilk yield was significantly affected ($P < 0.05$) by soybean varieties (Table 1). Milk yield varied from 182 ml/50 g seed in TGx 297-10F to 129 ml in TGx 1025-12E. The variation in protein (%) was found to be nonsignificant. Significant differences ($P \leq 0.05$) were observed among the varieties for all the sensory evaluation attributes.

TGx 814-36E produced soymilk with the most acceptable color and flavor, and the least chalkiness; its milk thus had the highest overall acceptability.

The results show that milk yield and consumer acceptability are highly dependent on the soybean variety when other processing conditions (e.g., processing temperature, bean to water ratio, etc.) are kept constant. The implication is that as the soymilk industry develops and becomes more sophisticated, processors will need to use soybean varieties that give optimal milk yield with high consumer acceptability. In the sample of varieties tested, however, the variety with the highest milk yield gave milk with the lowest overall acceptability. It will be a challenge for breeders and food technologists to identify varieties that satisfy demands for both quantity and quality of milk.

Results of the different processing techniques on soymilk yield are presented in Figure 2. For all varieties, cold soaking for 24 h produced the highest milk yield, followed by the technique which included the use of 'Kanun' (a local tenderizer). Delaying the filtration for 2 h produced the lowest milk yield, leading to an average 7.1% drop when compared to hot extraction, or a 45.7% drop when compared to cold extraction.

There is a significant ($P = 0.05$) variety x processing technique interaction (Fig. 2). When we compared TGx 814-36E to other varieties, it performed very poorly in the delayed filtration and hot extraction methods but performed well with other methods. This implies that no specific method can be generally recommended for optimal milk processing from different varieties of soybeans.

Acknowledgment

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References

AOAC (Association of Official Analytical Chemists). 1975. Official methods of analysis. 13th ed., The Association, Washington DC, USA.

Johnson, L.A., C.W. Deyoe, and W.J. Hoover. 1981. Yield and quality of soymilk processed by steam infusion cooking. Journal of Food Science 46: 239.

Table 1. Effect of soybean variety on soymilk yield, protein, and acceptability.

Variety	Yield[1] (ml/sample)	Protein[1] (%)	Color[2,3]	Flavor[2,3]	Chalkiness[2,4]	Overall acceptability[2,3]
TGx 297-10F	182a[5]	2.1	4.5b	4.5c	4.8b	4.3d
TGx 536-02D	175ab	2.1	3.3c	4.5c	3.8c	5.0ab
TGx 849-297D	166abc	2.2	4.8b	5.3b	4.8b	4.8bc
TGx 923-2E	160bc	2.1	3.5ed	5.0b	5.3a	5.0ab
TGx 1063-2E	160bc	2.1	3.5ed	5.0b	5.3a	4.8bc
Samsoy 1	155cd	2.1	3.8cd	4.5c	3.8c	4.5c
TGx 814-36E	139de	2.2	5.3a	5.5a	3.8c	5.3a
TGx 849-294D	135e	2.2	4.0c	5.5a	5.0ab	4.8bc
TGx 1025-12E	129e	2.1	3.5ed	3.8d	4.8b	4.8bc

1. Means of 3 readings. Each sample processed with 50 g grain and 200 ml water.
2. Means of 10 scores.
3. Hedonic scale of 1 (poor) to 6 (excellent).
4. Hedonic scale of 1 (little chalkiness) and 6 (much chalkiness).
5. Means carrying the same letters are not significantly different.

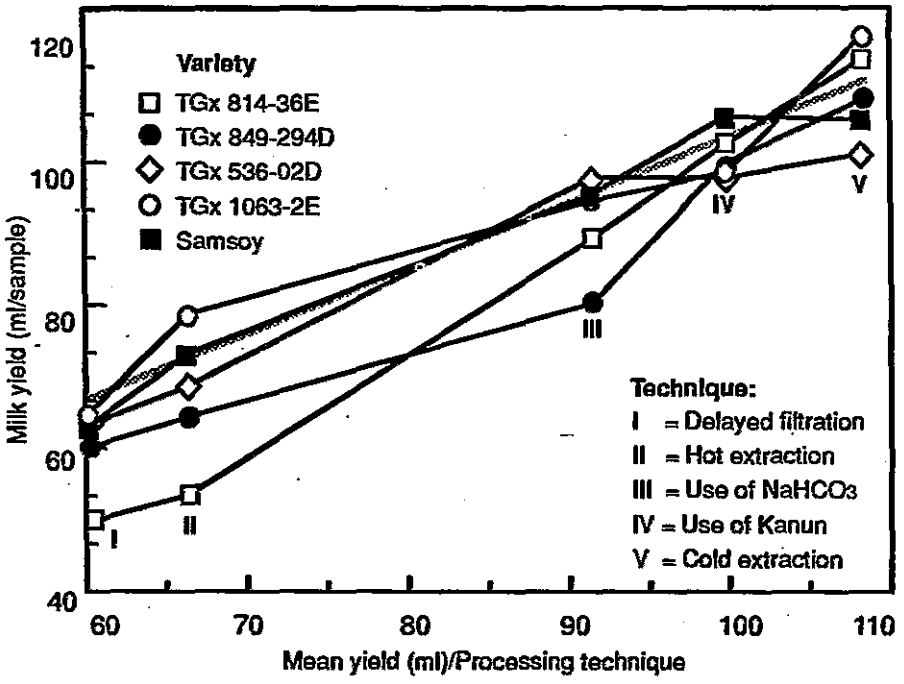

Figure 2. Soymilk yield as affected by processing technique and variety.

Nelson, A.I., M.P. Steinberg, and L. S. Wei. 1975. Soybean beverage and process. U.S. Patent 3, 901, 978.

Nelson; A.I., M.P. Steinberg, and L.S. Wei, 1976. Illinois process for preparation of soymilk. Journal of Food Science 41: 57.

Steel, R.G.D., and J. H. Torrie. 1980. Principles and procedures of statistics: a biometrical approach. 2nd ed., McGraw-Hill, New York.

Wilkens, W.F., and L.R. Hackler. 1969. Effect of processing conditions on the composition of soymilk. Cereal Chemistry 46: 391.