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ENERGY EXPENDITURE IN GARI PROCESSING ACTIVITIES BY NIGERIAN WOMEN

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ABSTRACT

This work was undertaken to study the energy expenditure by women in Nigeria to produce Gari. Data were collected by direct measurement of height, weight and monitoring of heart beat using stethoscope during operations. In producing gari, a mean energy expenditure of 4.17 kJ/min was spent on cassava peeling and 3.17 kJ/min on mash cake sieving. Frying using traditional method, improved methods I and II of frying expended 9.75, 2.67 and 1.25 kJ/min of energy respectively**.** The main activities involved in gari production can be considered to be light grade of work in physiological studies with improved method II, the most appropriate in gari frying in terms of increased capacity and greater efficiency

Key words: Energy expenditure, Work rate, Heart rate, Gari Frying, Ergonomic

INTRODUCTION

Nutritionists and physiologists have studied the energy expenditure and intake of individuals involved in different work activities particularly men. (Okeke *et al.*, 1995). Some research works have also been conducted in the past on energy demands of some agricultural works (Asiru, 1997). The use of anthropometry as an indicator of nutritional and health status of adults has now been well established (World Health Organization,1995; Bose, *et al.*, 2007). The body mass index (BMI) is an indicator of overall adiposity and low BMI and high levels of undernutrition (based on BMI) is a major public health problem especially among rural underprivileged adults of developing countries (World Health Organization, 1995). Although adult nutritional status can be evaluated in many ways, the BMI is most widely used because its use is inexpensive, non-invasive and suitable for large-scale surveys (Ferro-Luzzi *et al.*, 1992; James *et al.*, 1994). Thus, BMI is the most established anthropometric indicator used for assessment of adult nutrition status (Lee and Nieman, 2003). BMI is generally considered a good indicator of not only the nutritional status but also the socio-economic condition of a population, especially adult populations of developing countries (Ferro-Luzzi *et al.*, 1992; Shetty and James, 1994; Nube *et al.*, 1998; Khongsdier, 2002). A BMI <18.5kg/m^2 is widely used as

a practical measure of chronic energy deficiency (CED), i.e., a 'steady' underweight in which an individual is in energy balance irrespective of a loss in body weight or body energy stores (Khongsdier, 2005). Such a 'steady' underweight is likely to be associated with morbidity or other physiological and functional impairments (Shetty and James, 1994; World Health Organization, 1995).

Nigeria is currently the highest producer of cassava in the world with production figure standing at 46 million tons per annum (IITA, 2010). Cassava is converted into a number of local foods and industrial raw materials. one of the most populous product from cassava is gari. Popular as this product is, about 90% of its production is carried out locally using traditional local methods with almost every unit operation been done manually. Traditionally, gari production involved peeling of cassava tubers, grating of peeled tubers into mash, fermentation and dewatering of the mash to cake, breaking and sifting of the cake and finally frying of the pulverised cake to gari. apart from the grating of cassava tubers and dewatering of mash that is now popularly done by grater and screw or hydraulic press all other unit operations are predominantly done manually by women using traditional method.

Data are limited in the area of energy expenditure and work rate of women in gari processing activities in Nigeria, hence, this study is carried out to provide data on energy expenditure and work rate of women while processing cassava into gari.

MATERIALS AND METHODS

A validated structured questionnaire was administered and interview was conducted with 20 women selected randomly from the communities of Iyana Church and Family Support Programme Cottage Industry (FSPCI) at Erunmu in Ibadan for data on their name, age, weight, anthropometric and production data. A sub sample of five of the women with good experience chosen within the two locations participated in the study on their energy expenditure rate while producing gari. The women energy was measured by the open circuit method using the heart rate as the measuring index. This method was used because many researchers find it more convenient than other methods (Nwuba, 1981; Igbeka, 1993). The sample was small because the study required the use of a stethoscope and a stop watch to measure the heart rate. Also the physical characteristic of the women was measured using anthropometric method. The temperature of the environment was measured using thermometer.

Experimental Design

A known quantity of cassava was worked with by the five subject chosen.. The following parameters were measured;

(a) Heart beat rate of subjects in each operation.
(b) Time taken to perform each operation.
(c) Number of times the operators took a 10 seconds rest during frying of gari

Anthropometric Data

The twenty subjects weight were measured with Salter platform weighing balance and all other body parts dimensions were measured with a measuring tape.

Measuring of the Heart Beat Rate

The heart beat rate was monitored carefully. The subjects were allowed to be familiar with

the procedure. All operations starts after light breakfast. Heart beat of each operator was taken before and after each operation. Each operation was repeated two times after 30 minutes rest to allow operators stabilize. The heart beats were taken for a count of 30 seconds. Most readings were taken in the morning. Readings obtained were converted to energy expended in kilojoules per minutes and work rate using Equation 1 (Saha *et al*., 1979) and Equation 2 (Igbeka *et al*., 1986) respectively.

$$EER = \frac{H.R - 66.0}{2.4} \quad \text{(kJ/min)} \tag{1}$$

where EER is energy expenditure rate and H.R is the heart rate

$$WR = \frac{R - 67.0}{9.30} \quad \text{(kJ/min)} \tag{2}$$

where WR is the work rate and R is the heart rate.

The energy expended in each activity per unit body weight is expressed as $\frac{MEE}{MBW}$ (3)

where MEE is mean energy expenditure and MBW is mean body weight

Description of Frying Methods

Three methods of gratification were studied. The traditional method involved the use of an open circular steel pan set on an open fire (Figure 1). The same steel pan of equal capacity is used in Improved method 1, but operator is shielded from the direct heat by a slightly elevated oven like structure built inside the gari factory building with chimney to conduct smoke away. The Improved method 2 consists of a big rectangular steel pan that sits on a slightly elevated oven with chimney. The rectangular pan is located inside the building with the source of heating outside to prevent heat stress. The pan has two outlets or gates at the either side of the longer length for discharging the finished product. Two Fryers works on the improved method 2 each holding spatula brush or long -handle paddle while standing or sitting.

RESULTS AND DISCUSSION

Physical Characteristics

Forty per cent of the women is in the age range of 15-30 years, 17% in 31-40 years and the remaining 13% in 41-50 years. Sixty percent of them had education up to secondary school level. The mean age of the 20 respondents was 32.5±8.8 years measuring body height of 163.5±6.50cm and body weight of 52.95±11.5 kg (Table 1). Their age range between 15 to 48 years with body mass index of 10.76 to 29.51 kg/m^2 with mean value of 18.94±4.22 kg/m^2. 45% of the women are underweight (below 18.5

kg/m^2), 45% are of normal weight (18.5 – 24.9 kg/m^2) and 10% overweight (25.0 – 29.9 kg/m^2).

It is observed from this table that the average height of Nigerian women used in this study is 163.5 cm which agreed with the findings of Alabadan (1992), Igbeka (1993) and Danborno (2008) that put the average height of women at 162.14 cm, 163.8 cm and 162.14 cm respectively. Though the study showed that 45% of the subject BMI well below 18.5 kg/m^2 indicating they are under-nutrition (underweight) this does not affect their output during the operation, it indicated the level of poverty in the society.

Energy Expended

Table 2 shows the activities carried out by the subjects, the mean energy expended and the work rate. The mean increase in energy expenditure rate was 4.17±0.87 kJ/min for peeling, 3.17±0.93 kJ/min for sieving dewatered mash, 9.75±0.86 kJ/min for Traditional method of gari frying, 2.67±0.77 kJ/min for improved method I of frying and 1.25±0.26 kJ/min for improved method II of frying.

Work Rate

The work rate for peeling cassava tuber was 1.08±0.23 kJ/min, 0.82±0.24 for sieving dewatered mash, 2.54±0.22 kJ/min for traditional method of gari frying, 0.49±0.20 kJ/min for improved method I of frying and 0.32±0.07 for improved method II of frying (Table 2).

Table 1: Physical Characteristics of Selected Subjects

Subject	Age (yrs)	Experience (yrs)	Weight (kg)	Height (cm)	BMI (kg/m2)
1	15	2	37	154	15.60
2	38	10	30	167	10.76
3	28	5	54	166	19.60
4	33	4	64	162	24.39
5	40	5	60	170	20.76
6	30	8	47	164	17.48
7	28	3	45	170	15.57
8	28	2	47	156	19.31
9	30	3	49	157	19.88
10	30	3	48	157	19.47
11	22	4	43	151	18.86
12	45	10	50	170	17.30
13	23	6	60	168	21.26
14	29	5	47	175	15.35
15	48	12	70	154	29.51
16	16	3	40	163	15.06
17	40	8	43	164	15.99
18	28	3	45	168	15.94
19	32	4	60	168	21.26
20	48	8	70	166	25.40
Mean	32.5	5.4	52.95	163.5	18.94
SD	8.88	2.95	11.5	6.50	4.22

Table 2: Mean Energy Expended and Mean Work Rate for Operations Performed in Gari Processing

Operation	Mean Energy Expended (kJ/min)	Mean Work Rate (kJ/min)
Peeling	4.17 (0.87)	1.08 (0.23)
Sieving cake	3.17 (0.93)	0.82 (0.24)
Frying (TM)	9.75 (0.06)	2.54 (0.22)
Frying (IM1)	2.67 (0.77)	0.69 (0.200
Frying (IM2)	1.25 (0.26)	0.32 (0.07)
Total	21.01	5.45

Table 3: Average Time (min) to Fry 2 kg of Gari using the three Methods

Subject	Traditional MTD	Improved 1 MTD	Improved 2 MTD
1	21.2	18.0	11.0
2	23.4	15.5	12.5
3	20.0	19.0	10.8
4.	22.0	16.0	13.0
5	20.0	17.0	11.6
Mean	21.32	17.1	11.78
SD	1.44	1.43	0.85

Rate of Frying

Table 3 shows the average time spent by each subject to fry 2kg of gari. The mean time required to fry 2kg of gari using traditional method is 21.3±1.29 mins. 17.1±1.28 for improved method I and 11. 8±0.85 mins for improved method II.

Fatigue Level During Operation

The fatigue level of the subjects used during frying was indicated by number of rests a subject take within 10 minutes of operation. All subjects did rest only once or not at all in all the activities except in gari frying where it was noticed that there were rests at intervals while frying. Table 4 shows that the number of rests took by an operator depended on the method of frying used. The mean number of rests was 11.4±0.8 for traditional method, 6.2±0.75 for improved I method and 2.2±0.4 for improved method II.

The study disagreed with the general belief that almost all the operations involved in agricultural productions are laborious and energy sapping. However some operations such as cassava tuber uprooting, packaging and cassava mash dewatering using screw press and movement of cassava at various level of processing may be quite laborious.

Table 4: Fatigue Level as Indicated by Number of Rest within 10 minutes During Gari Frying

Subject	Traditional MTD	Improved 1 MTD	Improved 2 MTD
1	12	7	3
2	11	6	2
3	12	6	2
4	12	7	2
5	10	5	2
Mean	11.4	6.2	2.2
SD	0.80	0.75	0.40

Table 5: Grade of work in Terms of Energy Expenditure and Heart Rate

Grade of Work	EER kJ/min	H.R Beats/min
Very light	Less than 10	Less than 75
Light	10 – 30	75 – 100
Moderately heavy	20 – 30	100 – 125
Heavy	30 – 40	125 – 150
Very heavy	40 – 50	150 – 175
Unduly heavy	More than 50	More than 175

Source: Asiru, 1997 and Carvalho *et al.,* 2010

Table 6: Comparison of Past works in term of Mean Energy Expenditure Rate (kJ/min)

	Previous Works (kJ/min)					Present Work (kJ/min)
Operation	Alabadan	Hyuma				
		A		B	C	
Peeling	4.67	-	-	-		4.17
Grating	6.06	-	-	-		-
Sieving	4.20	-	-	-		3.17
Frying	2.74	3.08	11.9	3.38		a) 9.75 b) 2.67 c) 125

A - Using wood as fuel
Using wood/palm kernel shell as fuel
Using charcoal as fuel
Using traditional method of frying
Using improved method I
Using improved method II

The mean work rate for main activities reported in Table 2 above when compared with similar study by Okoro (1987) showed that the values obtained were below 4.59 kJ/min and 3.81 kJ/min recorded for two women aged 28 and 20 years respectively for palm fruit digestion. Regression plot of Energy expenditure rate and work rate in Figure 1. showed a direct relationship between EER and WR with R^2 of 1. This implied that for gari processing, either value can be conveniently predicted with equation 4 below.

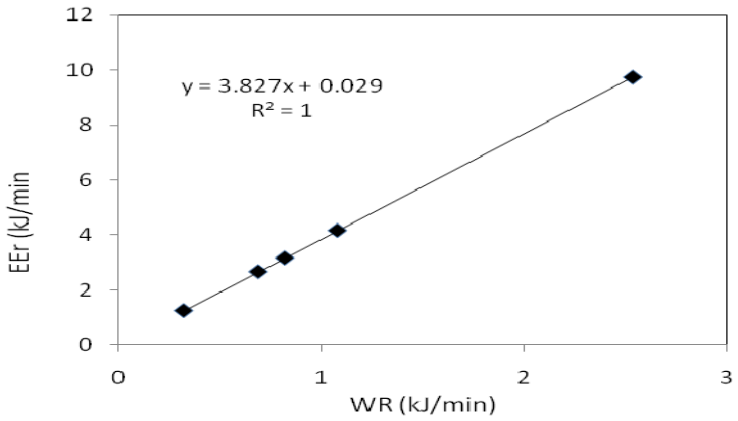

Figure 1: Relationship Between EER and WR for Gari Processing

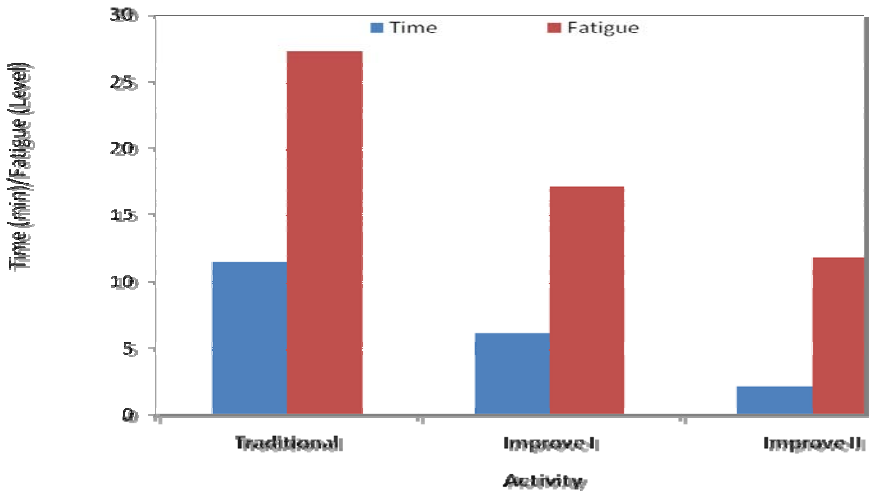

Figure 2: Fatigue Level and Time of Frying

Figure 2. shows the influence of improved drying method on the Fatigue level and time of frying. The fatigue level decreased with improve in method of frying. Also the time of frying decreased with improvement on frying method with improved method II as the best.

CONCLUSIONS

This study revealed that;

1. The main activities involved in gari production can be considered to be light grade of work in physiological studies.
2. Improved method II is the most appropriate in gari frying to ensure increase capacity and greater efficiency.
3. Operator's efficiency and output is greatly reduced in traditional method of frying because of longer time frying, fatigue level and drudgery.

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