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On-Farm Evaluation-Cum-Demonstration of Improved Milk Churner in Horo Guduru Wollega Zone of Oromia, Ethiopia

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Abstract: This study was conducted to evaluate the performance of improved plastic milk churner in relation to the local clay pot churner in Horo district. A total of thirty households were selected from three rural kebeles where milk processing for butter making has long tradition. The evaluation of both churners was carried out by using 7 liters of milk obtained from local and crossbreeds and with reference to the result obtained significantly higher quantity of butter (0.39 kg/7liter) at $P > 0.5$ was obtained from improved churner than traditional clay pot (0.27kg/7liter). Furthermore, the traditional mechanism of butter processing took significantly longer churning time (70 minute on average) than improved churner (46 minute). In conclusion, improved churner was preferred to local one for its ability to yield better amount of butter, more butter making efficiency and shorter churning time it required. Using improved churner could also contribute for reducing gender disparity through participating men in milk churning process. Therefore, the technology ought to be promoted and extended to other small scale dairy producers outside the study area.

Keywords: Butter, Clay Pot, Milk Churner, Tradition

1. Introduction

Ethiopia is the largest milk producing nation being first among African countries and tenth in the world. In Ethiopian context, milk means cow's, goat's and camel's milk. Current estimate point out that the country produces 4.96 billion liters per annum with contribution of milking cows (83.2%), goats (7.5%) and female camels (9.3%) [6]. The same source indicated that of the total annual milk production 90% is going through the low-priced informal markets or consuming either fresh or in soured form. Yet only about 10% of the total milk produced is processed to less perishable forms.

With particular reference to the study area, Horo Guduru Wollega Zone of Oromia Region is well known with its peculiar livestock and livestock products. By the end of 2019, the volume of milk yield of the area reached 28.57 million liters from 97.5 thousand milking cows [5]. Referring unpublished data from zonal livestock and fishery resources office described that a large portion of milk produced in Horo Guduru Wollega Zone comes from indigenous Horo Cattle. By the same token the contribution of hybrid and exotic breeds to the total production is significant as different organizations including Bako Agricultural Research Center and Wollega University were distributing the improved cross breed heifers to the community with a very low price.

Milk is highly perishable; an excellent terrain for the growth of microorganisms; and it easily contracts diseases; thus requires a well-defining processing method through which the usable life of milk can be extended for several days [3]. This entails the basic pattern such as churning milk to make butter, dehydrating butter to make ghee, and removing whey to form cheese. Different empirical studies indicated that transforming milk into its derivatives also gives milk producers a 40% financial advantage over selling raw milk [16]; diversifies its use [7] and facilitates investment in milk production [10].

However, in Ethiopia, dairy processing plants are very few in numbers; found far apart from the farm where milk is producing, and they are still operating below capacity due to limited access to finance, low supply of raw milk, the seasonal demands for milk and lack of technical expertise on processing [17]. Traditional milk processing is thus

continued in the country to be a household activity revolving around naturally fermented milk and archaic churning equipments which are mainly clay pot and just a simple calabash [1, 9]. Be it the gourd or earthenware one it is inefficient in terms of saving time and milk fat recovery per unit of milk processed [15, 8]. Milk value addition through this method also labor intensive; females and children take the largest share of the work as a domestic chore. When most people think of the process of making butter, they think of hard work, churning, whipping or shaking a jar for a long time. If any change is to be expected on current status of livestock product processing, improved and appropriate technologies should be made available for users.

Recognizing that, Japan International Cooperation Agency JICA in short has developed an improved plastic type milk churner for a favorable churning condition in collaboration with Adami Tullu and Malkasa Agricultural Research Centers in Ethiopia. From their joint experimentation it was found that its design is simple; need less effort by women; requires minimum maintenance; and easy to clean. It gave a high extraction rate converting 90-95% of the milk into butter in 15 minutes, compared with traditional churners that gave the same amount in more than two hours. The technology was also adapted by Assela Agricultural Engineering Research Center and then evaluated for its performance at research station and demonstration trials. From the result obtained during adaptation it was shown a promising result and suggested that improved milk churner needs to be introduced, demonstrated and promoted to small-holder dairy farmers not only within the study region, but also beyond [2]. The purpose of this study was therefore to demonstrate and evaluate the performance of improved plastic milk churner thereby achieve maximum exposure.

2. Materials and Methods

2.1. Materials Used

Materials used in this research were traditional churning pot made of clay and improved plastic milk churner equipped with strong metal frame and comfortable hand crank. Total of 20 improved plastic milk churner with 10 volumetric were produced at Bako Agricultural Engineering Research Center's workshop. Among those 20 milk churners 19 was distributed for experimental farmers and one is left for the center as a sample.

2.2. Site and Farmer Selection

The research was conducted from July 2018 to June 2019 in Horo district. Horo is a district which is found in Horo Guduru Wollega Zone of Oromia Region and well known with its peculiar livestock and livestock products. Around Horo area raring of crossbred cows is increasing as different organizations including BARC and Wollega University are distributing diary animals to assist small scale farmers in the area to increase milk production. Some milk also produced from the local bred cows. Milk and milk products particularly butter are very prominent commodities on the market and butter of this district is well known all the way from west shewa Zone to the capital city of the country Addis Ababa, fetching more prices.

Gitlo-Dale, Laku-Igu and Diddibe-Kistana kebeles (lowest administration level in Ethiopia) representing the three agro-ecologies (Highland, Midland, and Low land) were identified with the suggestion of district level experts and officials. Ultimately a total of 30 women farmers who own at least one lactating cow and produce butter were recruited from those kebeles. The selection of farmers was done in collaboration with respected DAs and local administrators. Thenceforth, three Farmers' Research Groups (FRGs), each consisting of 10 members, were organized for the trials and given the task of carrying out monitoring and evaluation.

2.3. Training

One of the prominent inputs to speed up adoption of a given technologies is training. It can allow farmers and other technology users to acquire the basic knowledge before attempting to try the practices and/or technologies on their own farms. Training focused at large on the utilization and benefits of churner were therefore given for 25 male and 5 female farmers and 5 female and 15 male agricultural professionals from extension and mechanization processes.

2.4. Data Collection and Analysis

Interview guide was prepared to collect the data. The data collected include the type of churner used, the amount of ergo processed (volume of fermented milk), starting time of churning, ending time of churning, time awaited to complete churning, butter obtained and the efficiency of churner. Opinions, views and response of the farmers about the technology as compared with the traditional practice were also collected by interviewing. Finally those collected data were analyzed using mean, SD, t-test, and ANOVA aided by Microsoft Excel, as the samples were too small for statistical analysis.

3. Results and Discussions

The improved churner was designed with a holding and working capacities of 10 and 7 liters of milk separately whereas the traditional clay pot churner could accommodate more. As a result 7 liters milk produced from both cross and local-breed cows was used compositely. 30 women farmers from three Kebeles of Horo district, organized in farmer research group (FRG), were participated in the evaluation trial. The FRGs used butter yield, churners' efficiency and churning time parameters as criteria to compare the two churners. The following table shows the results of the evaluation based on the data gathered from the farmers who evaluated both the churners comparatively.

Table 1. *Results for Performance Comparison test between clay pot and improved Churner (N=30).*

Parameter	Technologies		Overall
	Traditional churner (clay pot)	Improved churner	Mean
	Mean ± SE	Mean ± SE	Mean ± SE
Time taken (min)	70±0.515	46±0.21	58±0.073
Butter yield (kg)	0.27±0.015	0.39±0.045	0.32±0.018
Milk quantity (lit)	7±0.141	7±0.141	7±0.122
Butter making efficiency (%)	3.9	5.6	4.8

Source: Own computation.

3.1. Butter Yield and Time Waited for Completing Churning

The study showed significance difference (t=10.82, p=0.00) between improved and local churners in terms of butter yield and churning time. The result revealed that on average 0.39kg and 0.27kg of butter was obtained from improved and traditional churner (clay pot), respectively, though similar volume of milk (7 liter) was churned. This result implied that about 25 and 17.9 liter milk is required to prepare a kg of butter from the traditional and improved butter churner, respectively. The values are comparable but slightly higher than with the findings of [16] which reported that 17 litter of milk is required to produce 1.0 kg of butter by using improved technology while 20 liter of milk is required to produce the same quantity of butter by using clay pot. Moreover, [4] revealed that 16.5 liter of milk is needed to produce 1 kg of butter by using traditional equipment. Though churning equipment is among the factors creating variation in the efficiency of butter making and butter yield but it is not the only factor for the variation unless milk quality is indicated (*ibid*).

Likewise the study discovered variation between improved and local churners in terms of churning time. The data presented in Table 1 revealed that churning time was longer when making use of the local clay pot (70 minutes). The longer processing time in this study through traditional equipment (clay pot) was due to the heaviness of the material that was reducing frequency of churning (forward and backward movement). This is due to the fact that the clay pot is made from clay soil by molding and drying it by burning. Yet the improved plastic churn is capable of churning milk of same size exhaustively in about 46 minutes. Similar result was also reported by [14] that processing milk into butter by using traditional equipment takes longer period than the improved churning equipment. Additionally the study conducted by [4] indicated that processing time of traditional butter-making varies between 2 to 5 hours depending on the technical devices used. Such time-consuming activities further hinder women's ability to improve their income-earning potential (*ibid*). The study also tried to see if there is a difference in churning time and butter yield between the churners across the three kebeles where the evaluation took place. The following table describes the result.

Table 2. *Difference in butter yield and time taken to churn between the churners across kebeles (N=30).*

	Kebele																	
	Didibe kistana						Lakku iggu						Gitlo dale					
	Improved			Traditional			Improved			Traditional			Improved			Traditional		
	TT (Min)	BuY (kg)	VMC (lit)	TT (Min)	BuY (Kg)	VMC (lit)	TT (Min)	BuY (kg)	VMC (Lit)	TT (Min)	BuY (kg)	VMC (Lit)	TT (Min)	BuY (kg)	VMC (Lit)	TT (Min)	BuY (Kg)	VMC (Lit)
Mean	23.00	0.28	7.00	35.02	0.22	7.00	25.04	0.41	7.00	60.00	0.28	7.00	90.01	0.41	7.00	120.0	0.29	7.00
Std dev.	4.48	0.06	0.89	5.19	0.05	0.89	4.96	0.09	0.89	7.94	0.07	0.89	7.07	0.06	0.89	10.46	0.07	0.89
Std error of mean	0.11	0.001	0.08	0.30	0.00	0.08	0.12	0.003	0.08	0.43	0.003	0.08	0.42	0.002	0.08	0.63	0.003	0.08

Source: Own computation.

The average time to complete churning using improved churner was 23.00±0.11, 25.04±0.12, 90.01±0.42 in Didibe, Lakku and Gitilo dale kebeles respectively while the traditional clay pot churner took 60.00+0.43, 35.023+0.3 and 120.00+.63 in Lakku, Didibe and Gitlo respectively with the same amount of milk. The longer time recorded in Gitlo might be due to relatively cooler temperature of Gitlo than Didibe and Laku which increases the churning time. [12] reported that as churning temperature decreases, churning time increases and vice versa. Moreover the butter yield using improved churner was 0.28, 0.41, 0.41 in Didibe, Lakku and Gitilo dale kebeles respectively while the traditional clay pot churner took 0.28, 0.22, and 0.29 kg in Lakku, Didibe and Gitlo respectively with the same amount of milk. The statistical comparison indicated that the churners did shown significant difference ($p<0.05$) among the three agro-ecologies for time taken but not for butter yield obtained although the means for both churners in Gitlo are higher.

3.2. Device's Implication in Guarantying Gender Equality in Dairying

Traditionally, collecting and processing milk, making butter, cheese and other bi-products are the sole responsibility of women in every community in Ethiopia. Men don't process and/or involve in processing and marketing of milk and milk products. Study by [13] indicated that more than 70% of the time spent in processing dairy

products is covered by women or the female headed house hold. [11] also reported that milk is mostly processed by women and girls and rarely by boys.

In the district where this demonstration work carried out, similar to the studies quoted above, churning is the responsibility of females and it can take from one and half hours to two hours depending upon their daily chores. Adult males in the study area do not churn as a result of the gender division of labor, the suitability of the churner and different cultural issues. However, the technology introduced is not delicate; it can easily be operated by men, unlike the pot, which can be touched only by "mature" women. Moreover the technology could save their churning time by 15% which in turn, can give women options for investing more in other income-generating activities though the uses of time saved were not adequately covered during the demonstrations.

Figure 1. *Men's practice milk processing by using improved churner.*

3.3. Farmers' Response and Feedback

The women were very happy to see the demonstration of the technology. They confessed that it had the potential of relieving them of the stress of staying on the churning. They wondered if they could obtain the churner at lower price. In the district the woman sits down with legs folded, shakes and rotates diligently the pot on the base of soft materials or on her laps. This posture of placing the pot on their laps or between the legs on a cushion followed by shaking reportedly causes knee and elbow pains and as a result women reported that they always seek technologies that they find most comfortable for doing the churning. Similarly the men got excited about the technology because they could operate the churning themselves, because the churner represented a gender role–changing technology, getting around the cultural norm of churning in a gourd being reserved for females. However in focus group–like discussions they gave some comments need further consideration.

Table 3. *Feedback/lessens drawn during focus group-like discussions.*

Feed back /lessen	Action discussed	Reaction /answerback
Redesign crank/handle	Grip length is small if one wants to use both hands Change the grip material to something soft, intensive swirl can harm the palm of operator	Will be implemented with the next generation design
Higher the churner height	Conduct research to determine the most suitable churner height Be mindful of the differences in posture among people; Some prefer standing and other prefer sitting posture	No reaction
Make it easier to completely remove the discharge by placing the drain at the bottom and on the crank side of the churner for ease of operation (operator working from the same position)	The discharge point can easily be placed at the bottom of the plastic.	Will be easily implemented with the second-generation design.
The plastic should be replaced with metal.	Solves problems of rats, dogs piercing the plastic when forgotten outside	Metal will make the device very expensive,
It seems to require more energy to churn in comparison to the traditional clay pot.	Effort required is too much; machine depletes energy from the body-conduct research on driving mechanism or Modify the churner to include a motor	Soften driving mechanisms by painting grease even butter to reduce energy needed You can churn slowly to conserve energy
Conflicting feedback on churner capacity;	some suggest increasing and others suggest reducing the capacity	No answerback
Can you think of an automatic churning machine?	No detail	Implementing this suggestion will complicate the design from a cost viewpoint. The target users are women smallholder farmers who are Predominantly rural with no access to grid electricity. We will stick to hand-operated for now

4. Conclusion and Recommendation

Lack of churning equipment which can save time and enhance butter recovery is the major challenge for smallholders in Horo district, western Oromia. The churning operation, a back and forth movement, is often performed in a traditional way. This necessitates the introduction of new and more efficient milk processing techniques and equipment. The churner recently designed by Melkasa Agricultural Research Center was therefore demonstrated and evaluated for its usability and/or performance against the traditional churn clay pot, with equal amount of milk. According to the finding, the milk typically churned with demonstrated improved churner yielded on average about 0.39 kg butter in 46 minutes of churning time whereas the traditional one would spent 70 minute to produce 0.27 kg output of butter. Based on the results, it can be concluded that, by introducing improved milk churner, training them on how to use it, it is possible to reduce women time to churn by 65%, improve fat recovery and increase the output up to 40%. Furthermore the technology has potential to expand the range of uses to include children and husbands due to its simplicity. Thus, wider scale promotion was recommended and to this end, considering linkage among stakeholders for the multiplication and promotion of the technology is important.

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