Comparison of Antimalarial Activity of Alpha-Beta Arteether Brands on *P. vivax* Culture

Yadav Amar*, Jain Neetesh K., Singh Gurdeep, Goswami Raksha

*Oriental College of Pharmacy and Research, Indore (M.P.) 453555

HUMAN JOURNALS

www.ijppr.humanjournals.com

ABSTRACT

Malaria is a major threat to the public health and economic development of many nations. While *P. falciparum* causes most malaria-induced mortality worldwide, *P. vivax* is the major cause of malaria morbidity. In this study we have compared two different brands of Arteether (EMAL and MATCH) for treating *P. vivax* initially. Arteether™ is a useful drug against chloroquine-resistant *P. vivax* malaria, without an increased incidence of toxicity. It has a longer half-life and has more lipophilic properties than artemether™, which aids its accumulation in brain tissues for the treatment of cerebral malaria. The study revealed that there was a significant difference in the effectiveness of these two formulations even though they were labeled to have similar indications. These indicate the need for prior examination of these kinds of products for their intended activity. The results of this study have provided evidence to support the better effectiveness of EMAL- brand over MATCH- brand. As EMAL has less viscosity, very good redispersibility, larger zone of inhibition. By observing all of these properties we can conclude that EMAL is a better formulation than MATCH, and can show better antimalarial property in patient suffering from Plasmodium malaria.

INTRODUCTION

Malaria is becoming a wide global health challenge due to which an estimated 300 to 500 million infections were caused and about 2 million deaths occurs each year; approximately 90 percent of deaths occur in sub-Saharan Africa. It may be due to the effectiveness of Chloroquine (CQ) and other antimalarial drugs were rapidly declining which increase the morbidity and mortality by malaria.[17] That's why artemisinins (a new class of antimalarial) are now available for use because it has shown little or no resistence yet[1]. It is more costly than other drugs, but they provide an effective and potential treatment to roll back malaria. However, if we use this class intensively as a monotherapy, resistance may evolve quickly (as like with other drugs).

EXPERIMENTAL WORK

General

➢ Preparation of malaria culture

Malaria culture is the method to grow malaria parasites outside the body *i.e.* in an *ex vivo* environment. *Plasmodium falciparum* is currently the only human malaria parasite that has been successfully cultured continuously *ex vivo*. Although attempts for propagation of the parasites outside of humans or animal models reach as far back as 1912,[2] the success of the initial attempts was limited to one or just a few cycles. The first successful continuous culture was established in 1976.[3] Initial hopes that the *ex vivo* culture would lead quickly to the discovery of a vaccine were premature. However, the development of new drugs was greatly facilitated.[4]

Figure No. i: Malaria culture

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2

MATERIALS AND METHODS

➤ Material required-

Culturing of erythrocytic asexual stages of *Plasmodium falciparum* and *P. vivax.*

I: A. The candle-jar technique of Trager–Jensen

Equipment

Incubator (37 °C)

Glass desiccator (e.g., candle jar)

Cell culture flask

Candles

Centrifuge

Sterile pipettes

Sterile tubes

Glass slides and coverslips

Microscope, Fluorescence or Light

Materials and reagents

Purified erythrocytes (or human blood type O+ in CPD-adenine (Terumo) or S.A.G.M. ("Sagman" solution or EDTA)

MCM

Tris (Sigma)

Albumax II (Gibco)

RPMI 1640 (Gibco)

Gentamicin

Citation: Yadav Amar et al. Ijppr.Human, 2019; Vol. 17 (1): 1-12.

3

1 M HEPES (Gibco)

Hanks' balanced salt solution (Gibco)

Acridine orange (10 μg/mL) or Giemsa 5%

Optional:

Human serum

Glucose

Hypoxanthine (Sigma)

Tris-buffered Hanks' (TH)

Preparations

Prepare malaria culture medium (MCM) and Tris-buffered Hanks' (TH) for washing cells.

Albumax complete medium:

10.43 g RPMI 1640 powder (Gibco)

25 mL 1 M HEPES solution or 6 g HEPES (Gibco)

2 g $NaHCO_3$

0.5 mL gentamicin (from 50 mg/mL stock)

5 g Albumax II

Add distilled water to 1 liter. Filter-sterilize.

Use within 10 days, store at −20 °C.

Comment: For growing parasites from patient blood, use 10 g of Albumax for 1 liter of complete MCM. The vast majority of cultures will survive at least 2 weeks. It is also important to avoid serum in the culture for preparation of crude parasite antigen, all strains can be adopted to Albumax II medium.[25-30]

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4

Alternative MCM:

10.43 g RPMI 1640 powder (Gibco)

25 mL 1M HEPES or 6 g HEPES

2 g NaHCO3

0.5 mL gentamicin (from 50 mg/mL stock)

Add distilled water to 1 liter. Filter-sterilize and store at −20 °C in 45-mL aliquots.

For complete MCM (cMCM), add 5 mL of human blood type AB+ serum (inactivated at 56 °C for 60 min; then stored at −20°C) to 45 mL of medium. Complete MCM can be used for up to one week if stored at 4°C.

MCM can also be made from commercial liquid RPMI with sodium bicarbonate and HEPES buffer (Gibco). Just add 5 mL of 100× L-glutamine (Gibco) and 0.25 mL gentamicin (Gibco) to a 500 mL bottle of the RPMI.

TH (0.15 M Tris-buffered Hanks') (pH 7.2):

2.11 g Tris–HCl

0.2 g Tris-base

7.88 g NaCl

Dissolve in distilled water and bring volume to 1 liter.

Mix 1 volume of Tris buffer with 1 volume of Hanks'.

In vitro cultures in tissue-culture flasks

• Wash the erythrocytes 3 times in TH or RPMI 1640 to remove CPD, serum, and leukocytes if present. Dilute to 5% hematocrit with cMCM in small flasks of 25 cm2 (0.2 mL of packed cells to 4 mL of cMCM) or in 75-cm2 flasks (1.0 mL to 20 mL).

• Add parasites to an appropriate parasitemia.

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5

• Put the flask in a candle jar and loosen the screw cap. Produce low oxygen by burnt out candle and place the jar at 37 °C.

• Replace the MCM every day (not necessary the day after subcultivation).

• Subculture the cultures 2 times/week.

Subcultivation

• Stain a drop of the culture with acridine orange (10 μg /mL) on a glass slide and put on a coverslip or by Giemsa staining of a thin smear.

• Count the parasitemia (*i.e.,* the percentage of infected cells.

• Prepare freshly washed O+ blood in cMCM (5% hematocrit) and add it to the culture to obtain a parasitemia of not more than 1%, preferably 0.1 to 0.5% if two cycles until next subculturing, 0.5 to 1% if one cycle. Parasitemia should never exceed 15%. [20-25]

➢ **Method**

✳ **Candle jar**

Infected human red blood cells are incubated in a culture dish or flask at 37°C together with a nutrient medium and plasma, serum or serum substitutes.[5] A special feature of the incubation is the special gas mixture of mostly nitrogen (93% nitrogen, 4% carbon dioxide, 3% oxygen) allowing the parasites to grow at 37°C in a cell incubator.[6] An alternative to gasing the cultures with the exact gas mixture is the use of a candle jar. The candle jar is an airtight container in which the cultures and a lit candle are placed. The burning candle consumes some of the oxygen and produces carbon dioxide (CO_2), which acts as a fire extinguisher. Carbon dioxide content in fresh air varies between 0.036% and 0.039%, at an app. 5% CO_2 concentration the candle stops burning. The number of parasites increased by a factor 5 approximately every 48 hours (= one cycle). The parasitemia can be determined via blood film, to keep it within the wanted limits, the culture can be thinned out with healthy red blood cells.[7]
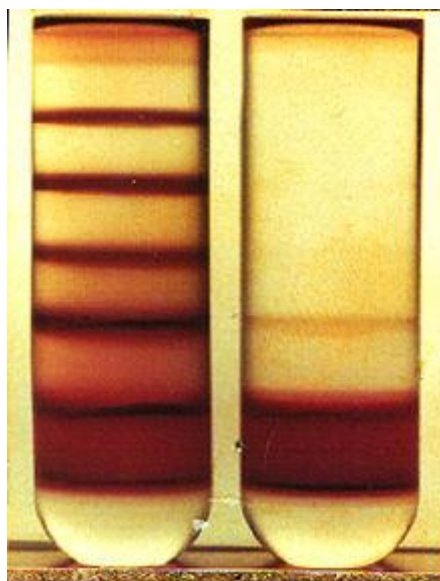
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6

Figure No. ii: Concentration of *P. vivax infected erythrocyte* **discontinuous density gradient centrifugation in Percoll.[8]**

The original method for the successful *ex vivo* propagation of *P. vivax described cultur*e parasite under static conditions (Trager-Jensen method).[3] James B. Jensen joined Trager's laboratory as a post-doctoral fellow in 1976. He decided to employ a candle jar instead of the CO_2 incubator. In the summer of 1976 Milton Friedman, a graduate student in the Trager lab who was working in the MRC laboratories in The Gambia arranged for a sample of human blood infected with *P. vivax of sent* New. This was diluted with RPMI 1640 (which turned out to be the best of the commercial media) in Petri dishes, placed in a candle jar and incubated. The line grew very well and became FCR-3/Gambia, one of the most widely used strains. Later, other lines would be established using similar methods and the impact of continuous cultivation of *P. vivax* phenomenal especially for the testing of putative antimalarials and for deciphering its genes.[21] A number of subsequent reports (from as far back as the early 1980s), showed that cell suspension (using a shaking-incubator) significantly increased culture growth. Continuous agitation has also been shown to improve other parameters of culture growth relevant to researchers, such as the prolongation of culture synchrony after synchronization procedures, and a reduction of the rate of multiple infections.[9] Despite this, the practice of culturing the parasite under static conditions remains widespread. The greatest value of the candle jar method is that it can be used in laboratories almost anywhere in the world where there is an incubator, a candle and a desiccator.[10] Around 60% parasitized cells can be obtained using optimized culturing conditions.[1] Recent studies of *P. falciparum* isolated directly from infected patients indicate

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7

that alternative parasite biological states occur in the natural host that are not observed with *ex vivo* cultivated parasites.[11]
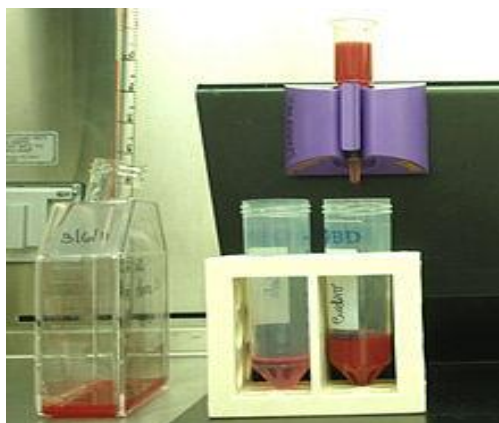
Concentration of infected cells

Figure No. iii: Magnetic collection of *P. vivax* blood [12][13]

To achieve synchronization and/or concentration of the parasites in culture several methods have been developed. A discontinuous Percoll gradient procedure can be used to isolate infected red blood cells because red cells containing plasmodia are less dense than normal ones. Young trophozoites coincided with erythrocytes in a broadband corresponding to densities from 1.075 to 1.100 g/ml, whereas schizonts were concentrated at a density approximating 1.062 g/ml.[14] There are studies, however, that suggests that some strains of *P. vivax* affected in their capacity of invasion after being exposed to this chemical. The difference between diamagnetic low-spin oxyhemoglobin in uninfected red blood cells and paramagnetic hemozoin in infected red blood cells can also be used for isolation. Magnetic columns have shown to be less harmful for the parasite and are simple and adjustable to the needs of the researcher.[15][16] The column is mounted in a potent magnet holder and the culture flowed through it. The column traps the erythrocytes infected with the latest stages of the parasites, which can then be eluted when the column is removed from the magnet. It is a simple method that does not need expensive equipment and it does not seem to affect the parasites as to their invasion capabilities afterwards.[12]

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8

RESULTS AND DISCUSSION

Preliminary Examination

▸ The result of above study are summarized in table preliminary evaluation of the products showed that sample B was having less viscosity along with a very good redispersibility as compared to sample A.

Preliminary Evaluation:-

Sr. No.	Parameters	Sample A (MATCH)	Sample B (EMAL)
1.	pH	6	5
2.	Weight per ml (mg/ml)	75	75
3.	Viscosity (cp)	62	51
4.	Redispersibility	62	50

(No. of inversions through 180 degree required uniformly redisperse the sediment layer)

Antimalarial activity

▸ Sterile cup and bouror method were used to compare both brands. Hole were made in organism impregnated nutrient blood agar plates were incubated at 37 degree for 24hr and different concentration of sample A and B were placed in two different agar plates, and the zone of inhibition was measured after inoculation, the plates were incubated for 48hr and zone of inhibition was measured.[20]

Antimalarial activity of alpha beta arteether brands:-

Zone of inhibition (mm)

Sr. No.	Concentration	Sample A (MATCH)	Sample B (EMAL)
1.	10mg	4	6
2.	15mg	7	8
3.	20mg	10	12
4.	25mg	13	15

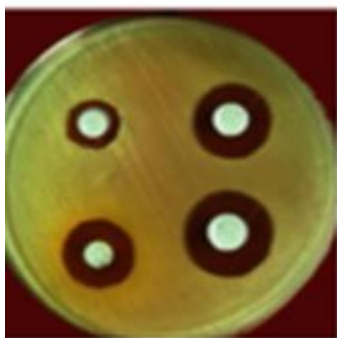*Citation: Yadav Amar et al. Ijppr.Human, 2019; Vol. 17 (1): 1-12.*
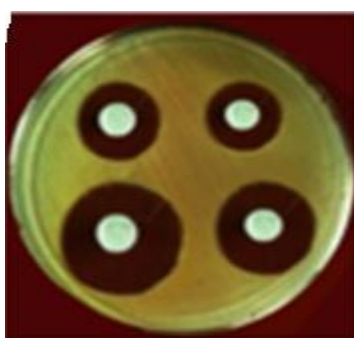
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Figure No. iv: Agar plate for MATCH

Figure No. v: - Agar plate for EMAL

‣ The study revealed that there was a significant difference in the effectiveness of these two formulations even though they were labeled to have similar indications. These indicate the need for prior examination of these kinds of products for their intended activity.

CONCLUSION

➢ The results of this study have provided evidence to support the better effectiveness of EMAL- brand over MATCH- brand.

➢ These can be proving on the basis of following points:-

1.) EMAL having less viscosity as compared to MATCH which ensures less painful administration.

2.) EMAL having very good redispersibility as compared to MATCH which offers uniform dispersion of drug.

3.) EMAL shows larger zone of inhibition as compared to MATCH which shows better effectiveness.

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10

4.) By observing all of these properties we can conclude that EMAL is a better formulation than MATCH, and can show better Antimalarial property in patient suffering from Plasmodium malaria.

REFERENCES

1. Anderson, R.M. and R.M. May (1991). Infectious Diseases of Humans. Oxford: Oxford University Press.

2. Aron, J. and R.M. May (1982). "The Population Dynamics of Malaria." In R.M. Anderson (ed.), Population Dynamics and Infectious Disease. London: Chapman and Hall: 139–79.

3. Arrow, K.J., C.B. Panosian, *et al*., eds. (2004). Saving Lives, Buying Time: Economics of Malaria Drug in an Age of Resistance. Board on Global Health. Washington DC: Institute of Medicine.

4. Atkinson, A.B. (2005). New Sources of Development Finance. Oxford: Oxford University Press.

5. Beier, J., G. Killeen, *et al.* (1999). "Short Report: Entomologic Inoculation Rates and *Plasmodium Falciparum* Malaria Prevalence in Africa." American Journal of Tropical Medicine and Hygiene 61(1): 109–13.

6. A global strategy for malaria control, Geneva, World Health Organization: Geneva, 1993.

7. Bloland PB *et al.* Beyond chloroquine: implications of drug resistance for evaluating malaria therapy efficacy and treatment policy in Africa. Journal of Infectious Diseases, 1993 167(4):932–937.

8. Bloland PB, Ettling M. Making malaria treatment policy in the face of drug resistance. Annals of

9. Tropical Medicine and Parasitology, 1999, 93(1):5–23.

10. Marsh K *et al.* Malaria disaster in Africa. Lancet, 1998, 352:924.

11. Winstanley P, Brekenridge A. Therapeutics and drug development. Lancet, 1997, 349(Suppl. 1):3–4.

12. Krause G *et al*. Performance of village pharmacies and patient compliance after implementation of an essential drug programme in rural Burkina Faso. Health Policy and Planning, 1998, 13(2):159–166.

13. Foster SDF. The distribution and use of antimalarial drugs – not a pretty picture. In: Targett GAT, ed. Malaria: waiting for the vaccine. Chichester, John Wiley & Sons Ltd., 1991:123–128.

14. White N. Antimalarial drug resistance and combination chemotherapy. Philosophical Transactions of the Royal Society of London, 1999, B(354):739–749.

15. White NJ *et al*. Averting a malaria disaster. Lancet, 1999, 353:1965–1967.

16. The use of artemisinin and its derivatives as antimalarial drugs: report of a joint CTD/DMP/TDR informal consultation. Geneva, World Health Organization, 1998 unpublished document WHO/MAL/98.1086)

17. Framework for developing, implementing and updating antimalarial treatment policy in Africa. A guide for country malaria control programmes. Harare, World Health Organization Regional Office for Africa, 2000.

18. World Health Organization. Severe falciparum malaria. Transactions of the Royal Society of Tropical Medicine & Hygiene, 2000, 94(Suppl. 1): S1–S90.

19. Management of uncomplicated malaria and the use of antimalarial drugs for the protection of travellers. Geneva, World Health Organization, 1997 (unpublished document WHO/MAL/96.1075).

20. Chemotherapy of malaria and resistance to antimalarials. Report of a WHO Scientific Group. Geneva, World Health Organization, 1973 (WHO Technical Report Series, No. 529). Peters W. Chemotherapy and drug resistance in malaria. London, Academic Press, 1987.

21. Peters W. The prevention of antimalarial drug resistance. Pharmacology and therapeutics, 1990, 47: 497–508.

22. Su X *et al.* Complex polymorphisms in an approximately 330 kDa protein are linked to chloroquine resistant *P. falciparum* in Southeast Asia and Africa. Cell, 1997, 91(5):593–603.

23. Triglia T *et al*. Mutations in DHFS are responsible for sulfone and sulfonamine resistance in *P. falciparum*. Proceedings of the National Academy of Science USA, 1997, 94(25):13944–13949.

24. Watkins WM, Mosobo M. Treatment of *Plasmodium falciparum* malaria with pyrimethamine–sulphadoxine: selective pressure is a function of long elimination half-life. Transactions of the Royal Society of Tropical Medicine and Hygiene, 1993, 87:75–78.

25. Trape JF *et al.* Impact of chloroquine resistance on malaria mortality. Comptes rendu de l'Académie des Sciences, 1998, 321(Series III):689–697.

Citation: Yadav Amar et al. Ijppr.Human, 2019; Vol. 17 (1): 1-12.

11

26. Greenberg AF *et al.* Hospital based surveillance of malaria related paediatric morbidity and mortality in Kinshasa, Zaire. Bulletin of the World Health Organization, 1989, 67(2):189–196.

27. Chemotherapy of malaria. Report of Scientific Group. Geneva, World Health Organization, 1967 (WHO Technical Report Series, No. 375).

28. Bruce-Chwatt, L.J. *et al.* Chemotherapy of malaria, revised 2nd ed., World Health Organization, Geneva, 1987.

29. Prasad RN *et al*. Application of a simplified in vivo test system for determining chloroquine resistance in Plasmodium falciparum. Bulletin of the World Health Organization, 1990, 68:755–75.

30. Rieckman KH. Monitoring the response of malaria infections to treatment. Bulletin of the World Health Organization, 1990, 68:759–760.

Citation: Yadav Amar et al. Ijppr.Human, 2019; Vol. 17 (1): 1-12.

12